Cotton and Cotton Oil.

COTTON.

Planting, Cultivating, Harvesting and Preparation for Market.

COTTON SEED OIL MILLS.

Organization, Construction and Operation.

CATTLE FEEDING.

Production of Beef and Dairy Products. Cotton Seed Meal and Hulls as Stock Feed.

FERTILIZERS.

Manufacture, Manipulation and Uses.

FULL INFORMATION FOR INVESTOR, STUDENT AND PRACTICAL MECHANIC.

PROFUSELY ILLUSTRATED WITH ORIGINAL DRAWINGS.

By D. A. TOMPKINS,

AUTHOR OF

Cotton Mill Processes and Calculations; Cotton Mill Commercial Features; American Commerce, Its Expansion; Cotton Values in Textile Fabrics.

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Preface.

I was born on a cotton plantation in South Carolina in 1852, and lived on it continuously until 1867. In subsequent years I was from time to time on the plantation, and thus have been in good contact with cotton planting before, during and after the Civil War.

I was educated and trained as an engineer. In the pursuit of my profession, I have designed and had charge of the construction of many cotton mills, cotton seed oil mills, and fertilizer works.

This volume, Cotton and Cotton Oil, is based on the experience acquired on the plantation and in the execution of these various engineering and industrial works. The matter is put in book form as the best means of keeping together the valuable results of the work, and for what value the records may be to the present and succeeding generations, who may be interested in these subjects.

D. A. TOMPKINS.

Charlotte, N. C., July 15, 1901.

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CHAPTER I.

Introduction.

For the ancient history of cotton, dating 1,000 years before Christ, the practical man of to-day cares very little. Even the minor details of its introduction into the United States possesses only historical interest and this will be taken up only to illustrate the evolution of the industry.

The early colonists naturally experimented on their new found soil with all of the divers seeds that they could obtain from all parts of the earth. Thus, cotton became an early experimental crop, beginning in Virginia about the year 1600, and continuing in all of the Southern latitudes for nearly two hundred years before it came to be seriously regarded as a useful crop.

During this epoch a great army of hand weavers had sprung up in England, and it was becoming a serious problem with them to get yarn to weave.

In all times and places, when there is a serious demand for any invention, the genius of the age soon develops and perfects that invention. In 1767 James Hargreaves invented in England the spinning jenny, by which one operative could run as many as twenty spindles, instead of one, as theretofore. This was successively improved by Arkwright and Crompton in England and others, so that it soon became an easy matter to provide yarn for the hand weavers. After the power loom had been introduced by Cartwright also in England in 1785, the world's consumption of all kinds of yarn became immensely increased, and thus the demand for raw textile fibres was a constantly growing one.

The American colonists took a growing interest in cotton production, and made every effort to meet the demand from the mother country, and also the new demands of the new independent colonies.

In 1786 Governor Tattnal, of Georgia, received some Sea Island seed from the Bahama Islands, and encouraged its production in the coast region.

About the same time, a Mrs. Burden, of South Carolina, promoted its growth on the sea islands of that State.

Several difficulties prevented the rapid spread of cotton culture in those days. Scarcity of labor in the new country, for the tedious process of harvesting or "picking" was an important factor; but the prime difficulty was in separating the useful lint from the then useless seed. This work was done entirely by hand until the ancient roller gin was brought over.

A. Mr. Dubreuil, of Louisiana, is said to have had one of the first gins of any kind in America. A more practical machine seems to have been introduced from the Bahama Islands by Dr. Joseph Eve, of Augusta, Ga., about the same time (1790). He is reported to have been the first to run a gin by power.

As the colonists gradually found their way inland, the character of the cotton which they continued to plant, changed from the Sea Island varieties, and began to develop a well marked type known as "upland." The seeds of upland cotton were even more difficult to separate than the other varieties, so that, although plantation labor began to be more plentiful by the importation of slaves, the growth of cotton could not become an extensive industry until a machine could be perfected for the separation of the seeds.

As in the invention of other machinery, a crying necessity stimulated inventive genius. The roller gin was already in use, and worked well for Sea Island cotton. In 1793, Eli Whitney, then living near Savannah, Ga., invented a cotton gin, comprising many of the features of the gin now in use for upland cotton. In 1794 he obtained his patent. In 1795 Hodgen Holmes, of Augusta, Ga., invented the saw gin, an improvement on Whitney's machine. In 1796 he obtained his patent. Thus in the

period from 1793 to 1796, the saw gin became a standard machine, and an epoch maker in the history of cotton.

The first power saw gin, which is to say the first real practical and productive gin in the world was made by Hodgen Holmes and was run by water power in Fairfield county, South Carolina, by Mr. James Kincaid in 1795.

The details of the invention of the saw gin are fully set forth in another chapter.

The effect of this invention upon the cotton production of the country was wonderful. As soon as a few of these machines could be made and put upon the market, it was seen that with the available labor it was easy to increase the cotton production many fold.

In 1790 the production of cotton was equivalent to 3,000 bales of 500 pounds each, and in 1798, about the time the use of saw gins became general, the production was increased to an equivalent of about 30,000 bales of 500 pounds each. At this time cotton was put up in bales or bags weighing about 225 pounds each. For the purpose of comparison, all statistics in this book have been reduced to our present average bale of 500 pounds gross.

It soon became apparent that the productiveness of the soil would justify much more cotton planting than the available labor could handle, even with the help of the cotton gin. This idea fostered a great importation of negro slaves, and thus the growth of slavery and the increase of the cotton crop were simultaneous, each being sustained by the other. This material result was in opposition to a strong sentiment against slavery.

The cotton crops steadily increased on this basis, building up and enriching an agricultural population which became an aristocracy in the Southern United States. The cotton crop had grown to 4,000,000 bales in 1861, being mostly produced by the labor of the 4,000,000 slaves.

From 1861 to 1865 the Civil War interfered with agricultural operations so that the average annual production during that period was reduced to a half million bales.

The Civil War resulted in the abolition of slavery. The ill-advised enfranchisement of the slaves who were led by dishonest adventurers, induced a condition of political and industrial disorder. This condition retarded the recovery of the cotton growing States from the disastrous effects of the war; and hence it required about ten years after the war for the cotton planters to again reach a production of 4,000,000 bales. Since that time, the crop has continually increased, reaching to nearly 10,000,000 bales in 1900, as exhibited by the following table:

TABLE I.

SHOWING THE PRODUCTION AND PRICE OF COTTON FROM 1790 TO 1900.

Year	No Bales 500 Lbs. Gross	Price Per Lb in New York.
1790	3,000	26 0
1791	4,200	26.0
1792	6,300	29.0
1793	10,400	32.0
1794	16,700	33.0
1795	16,700	36.5
1796	20,800	36.5
1797	22,900	34.0
1798	31,200	39.0
1799	41,600	44.0
1800	73,000	28.0
1810	177,000	16.0
1820	331,500	17 0
1830	689,800	10.0
1840	1,737,700	8.9
1850	2,085,800	12.3
1860	4,668,900	11.0
1865	250,000	80.0
1870	2,862,300	24.0
1880	5,449,200	12.0
1890	7,311,400	11.5
1900	9,436,400	8.7

Continued economies in the cost of production, and continued demand for cotton goods, together with a great increase of cotton mill building in the cotton producing States will no doubt lead to still further expansion of the crop to perhaps 15,000,000 within the next decade.

Coincident with the upbuilding of the cotton growing

industry to such proportions, there has been great activity in the production of mechanical devices for the preparation and handling of the crop.

The separate discussion of these various devices and their influence on the scope and character of cotton production furnishes the theme for the most of Part I., of this book.

TABLE II.

SHOWING CHRONOLOGY OF SOME EVENTS RELATING TO COTTON.

1600.—Introduction of cotton into Virginia.

1730.—John Wyatt spins first cotton by machinery in England.

1738.—John Kay invents the fly shuttle.

1767.—James Hargreaves invents spinning jenny.

1769.—Richard Arkwright invents drawing rolls for spinning machine.

1776.—Samuel Crompton invents mule jenny.

1785.—Edmund Cartwright invents power loom.

1787.—First cotton mill in Beverly, Mass.

1790.—First cotton mill in Pawtucket, R. I.

1794.—Eli Whitney invents cotton gin.

1796.—Hodgen Holmes invents saw gin.

1796.—First cotton mill in Statesburg, S. C.

1813.—First cotton mill in Lincolnton, N. C.

Part 1.

COTTON.

CHAPTER II.

The Invention of the Saw Gin.

Much as has been written on the subject of the invention of the saw cotton gin, the question as to the credit for fundamental ideas, and their development into a commercial machine, seems yet to lack authoritative discussion.

It is so easy to collate a large amount of matter from writers, who themselves have copied the works of others, purporting to relate history, that it is small wonder that well nigh as many errors as facts should have been frequently copied and re-copied. This seems to be especially the case in America concerning the cotton gin, on acount of its being an American invention of such note, and of comparatively recent date.

Crude cotton as it is produced in the field, consists of fluffy masses of cotton lint adhering to seeds. It is called in this condition "seed cotton." The varieties of cotton may be divided into two general classes; "Upland" and "Sea Island." This distinction is based mainly on the length of the fibre or "staple" the former having fibres varying from $\frac{5}{8}$ to $1\frac{1}{4}$ inches and the latter from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. The lint of upland cotton adheres very firmly to the seeds, appearing to grow out of it like wool from a sheep's back. The seeds, after being denuded of lint as well as possible, still have a woolly appearance. In a great many sub-varieties the seeds are green in color, thus giving to upland cotton, in general, the name "green-seed cotton," as distinguished from Sea Island cotton, whose seeds are black. Sea Island, or long staple cotton does not adhere so closely to the seeds, and it can be easily pulled off clean, leaving the seeds perfectly smooth. These seeds are vulgarly called "bald-headed seed."

A gin is a machine for separating lint cotton from the seed. The word gin is supposed to be a contraction of engine, and the word has been used to indicate a number of

contrivances for doing work, such as hoisting, etc., on the same reasoning that in England at the present time, the machine in use for carding cotton is known as the carding engine.

Recent usage, especially in America, has restricted the use of the word engine to mean some prime mover, and the use of the word gin to mean cotton gin.

The term cotton, as commercially used in the United States, refers generally to upland cotton, that being the kind mostly produced. When Sea Island Cotton is referred to, it is specially mentioned. In the same way the term "gin" is used to designate the saw gin, which is the particular kind in use with upland cotton. The machine used for separating Sea Island cotton from the seed is known as the "roller gin."

The saw gin has a saw cylinder, made up of circular saws, spaced by collars on a mandrel or shaft. The saws project into a breast box, through grooves or ribs set close enough together to prevent the passage of seed. The teeth pull the lint through the ribs and leave seed behind. Revolving in an opposite direction to the saw- toothed cylinder, parallel to it, and in a contiguous box, is another cylinder covered with bristles, which brushes the lint out of the teeth and delivers it into a room or into a condenser. The brush cylinder revolves 4 or 5 times as fast as the saw cylinder.

The first method of separating lint from the seed was naturally by hand picking. The next method, originating in India about 300 B. C., was by means of rollers, which running closely together, would pull the lint through and leave the seed behind.

The roller gin now in use for ginning sea island cotton is a modern development from this India gin.

As most of the ancient Eastern cottons were of the black seed varieties, the roller gin was fairly successful, though the seeds would often become cracked between the rollers and pass on through and mix with the lint. The seeds contain considerable water and nitrogenous matter,

so that those crushed are liable to decay, and thus to give to lint cotton prepared in this manner a foul odor.

During the War of the American Revolution, and immediately thereafter, cotton culture began to receive considerable attention in the Southern States. As the coast country was the first to be settled; and as the valuable Sea Island varieties grew to perfection on that soil, these were first cultivated. They were prepared for market by hand, and by the roller gins, both processes being very slow. The roller gin then in use would clean about 5 times as much cotton per day as could be cleaned by hand.

When upland varieties began to be cultivated further inland where Sea Island would not grow, the roller gin proved entirely inadequate and unsuitable, so that the extension of cotton growing soon reached its limit. In many cases, it surpassed the limit, and much cotton was wasted for want of being separated from its seed, and made ready for market.

In 1792, Eli Whitney of Massachusetts went by boat to Savannah, Ga., from which place he intended to go into the interior as tutor in a private family. On the same boat was traveling Mrs. Nathaniel Greene, the widow of the American Revolutionary General, who was returning from a Northern trip to her home at Mulberry Grove, near Savannah, Ga. On this journey Whitney naturally made the acquaintance of Mrs. Greene. Arriving in Savannah, he failed to perfect his arrangement for teaching and accepted an invitation from Mrs. Nathaniel Greene to make his home at her house and pursue the study of law, which was his great desire.

While he was in Mrs. Greene's house he exhibited great talent for mechanics, and made himself useful in that respect around the plantation.

In the spring of 1793, some old comrades of General Greene: Majors Brewer, Forsythe and Pendleton, who lived near Augusta, Ga., called on Mrs. Greene. In the course of their visit they discussed the troubles of agriculture in the upper country, and mentioned the fact that

much upland cotton could be profitably produced if there were only some machine for separating the lint from the seed. Mrs. Greene proposed that they talk over the matter with young Whitney. The result of that visit was that Whitney was given a room in the basement of the house, and after considerable experimenting, produced a machine that successfully separated the lint from seed.

Fig. 1 is copied from an old print which is said to represent Whitney's original model. This is not an official record, but it is confirmed by comparison with the patent drawing, Fig. 3.

In 1793 Whitney went to New Haven, Conn., to confer with his old friend and patron, Elizur Goodrich and others, in relation to obtaining a patent.

The original description in Whitney's own words, accompanying his petition for patent was filed with Thomas Jefferson, Secretary of State at Philadelphia, June 20, 1793. Whitney also made affidavit concerning his invention before Elizur Goodrich, Notary Public, and Alderman of New Haven, Conn., Oct. 28, 1793.

A patent was issued to Eli Whitney March 14, 1794, and signed by George Washington, President, Edmund Randolph, Secretary of State and Wm. Bradford, Attorney General.

During some litigation over validity of the patent in the United States District Court in Savannah, Georgia, 1804 a copy of the complete patent and specification and drawing was filed with the court. This copy was certified by James Madison, Secretary of State, April 27, 1804, as shown by Fig. 2.

This copy, taken from the records of the Court, is given verbatim in the Appendix, marked Document II. Fig. 3 is a photograph of the drawing, accompanying this certified patent, and Fig. 6 is the certification of the whole set by the Deputy Clerk of the United States Court.

These documents are now on file in the United States Court House, Savannah, Ga., and are believed to be the only authentic records of this patent in existence. The

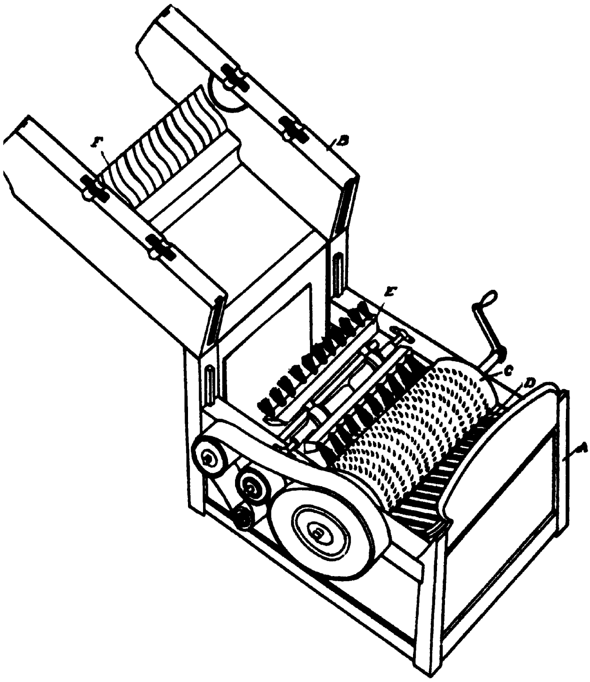


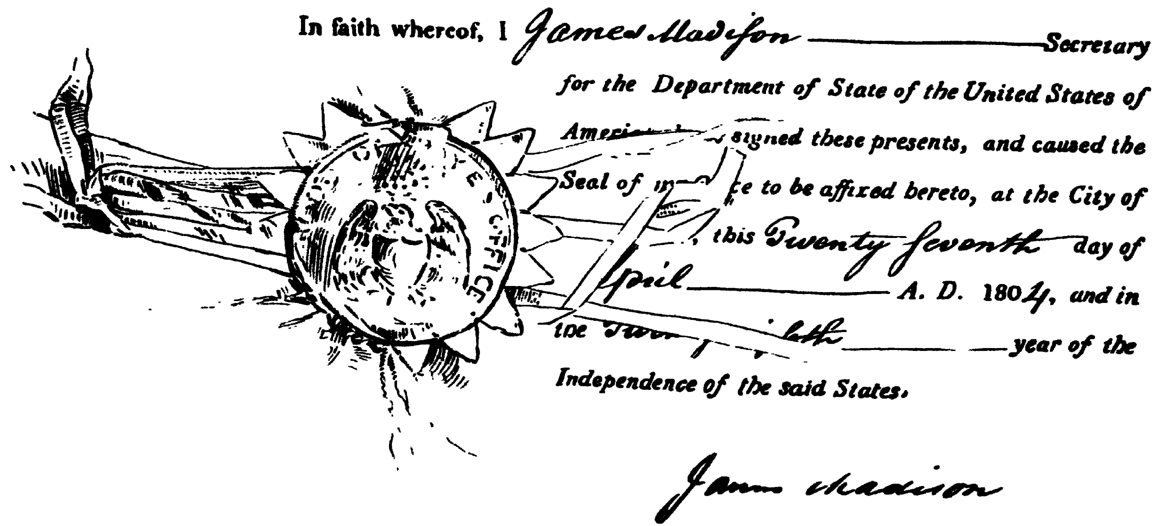
FIG. 1

Whitney's Original Model.

original patent papers filed in the Patent Office by Whitney in 1793, were destroyed by the Patent Office fire in 1836. See Appendix, Document IV. As soon as possible after this fire, the authorities made efforts to obtain copies of all papers that were destroyed. It so happened, however, that they never secured the certified copy on record in Savannah, Ga., but they received from some source not shown on the records, on May 2, 1841, what purported to be a copy of the Whitney patent. Figs. 4 and 5 are the drawings accompanying the document. The full text of the 1841 specification is given in the Appendix, Document III.

It will be noticed in comparing this 1841 record with the original, that the original specification gives a much more detailed account of the method of constructing the gin, even to the extent of describing and illustrating the meth od of cutting the wire which was used for making the spiked teeth in the cylinder, and describing in great detail the method of inserting the bristles in the brush, and giving some alternate methods; and in all other cases referring to alternate methods, the particular alternate methods are described. But the very clear and extended specification in the original makes no suggestion of an alternate method of constructing the cylinder, as for example, the use of circular saws. Neither does the original drawing show any suggestion of saws. But the specification of 1841 concludes with a paragraph not found in the original, viz: "There are several modes of making the various parts of this machine, which, together with their particular shape and formation are pointed out and explained in a description with drawings, attested, as the Act directs, and lodged in the Office of the Secretary of State."

There is a curious mistake noticeable in the drawing of 1841, Fig. 4, that would surely indicate that Eli Whitney himself never even saw it; that is, the handle by which the machine is to be turned, is applied to the brush shaft, instead of the main cylinder, which is the way it is described in both


In faith whereof, I James Madison ——— Secretary for the Department of State of the United States of America ... signed these presents, and caused the Seal of my Office to be affixed hereto, at the City of ... this Twenty seventh day of April ——— A. D. 1804, and in the Twenty ... ——— year of the Independence of the said States.

James Madison

Fig. 2.

Madison's Certification of the Original Patent Sheets; Copied in the Appendix.

the authentic and the substituted specification; and this is the only way it could be made to work in practice.

Whitney's authentic specifications say, in describing the brush: "IV. The clearer, C Fig. I, is constructed in the following manner: Take an iron axis, perfectly similar to that described as extending through the cylinder, except that it need not be so large nor fitted for the application of a winch.

Whoever made the drawing for the patent office after the fire, could not have understood the principles of the gin, otherwise, this error in placing the winch (or hand crank) could not have occurred.

These substituted drawings have some of the features of the authentic patent drawings, besides some features of the gins that were built about 1841. They also embrace a number of features totally at variance with the principles of Whitney's or any other gin.

The substituted drawings show sketches of saws, while there is nothing in the authentic drawings or specifications, even in the most remote way, suggesting the idea of a saw. These peculiar additions, which occur in the substituted documents, were evidently intended to establish a claim for Whitney for the invention of the saw gin, whereas the authentic patent papers amply refute such a claim.

The substituted specifications, while being in the main a synopsis of the authentic specifications, omit all reference to drawings, either original or substituted.

There were tried in the United States Court, district of Georgia, 27 suits for infringement of the Whitney gin patent. Among the papers in the evidence introduced in these suits, is a certified copy of a patent for a gin, issued May 12, 1796, to Hodgen Holmes of Augusta, Ga.

A certified copy of this patent is given in full in the Appendix, Document VI.

No drawing accompanies the patent, and the specifications are very meagre. The patent in itself does not in any way describe the fundamental operations of the gin, and does not state whether the teeth are made of wire or cut

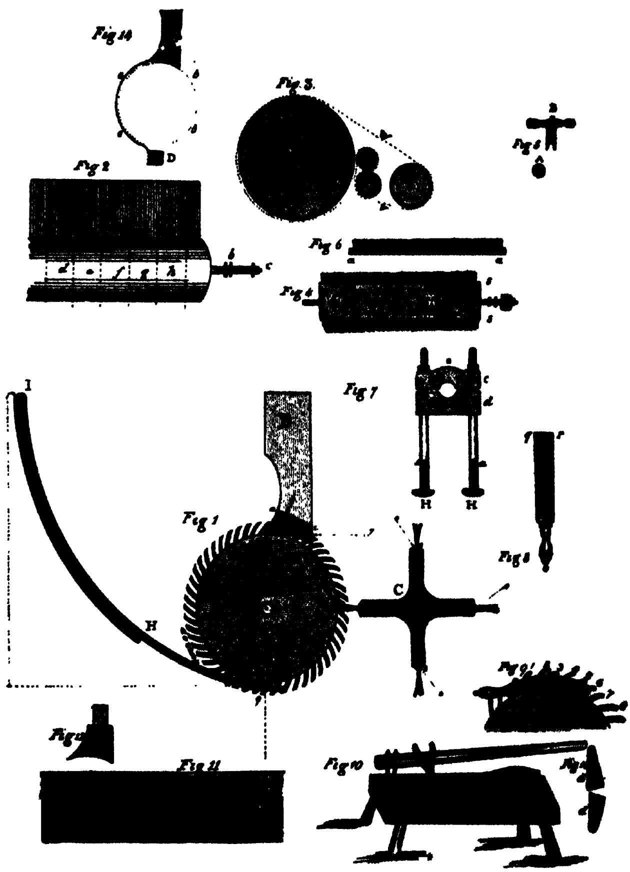


FIG. 3.

Original Certified Patent Drawing.

Note that no saws are shown.

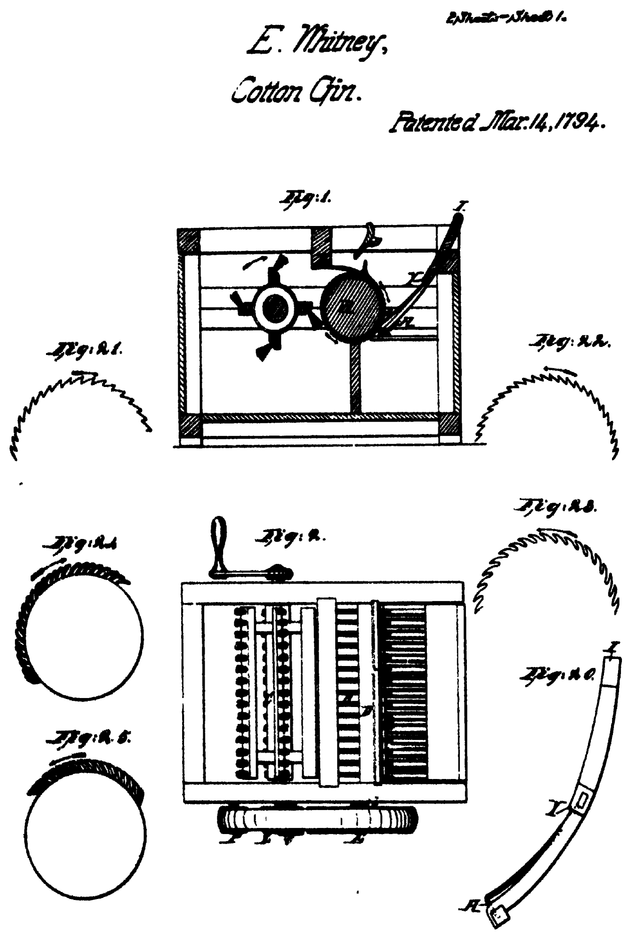


FIG. 4.

Drawing Accompanying the Substituted Patent.

Note that saws are shown on this drawing.

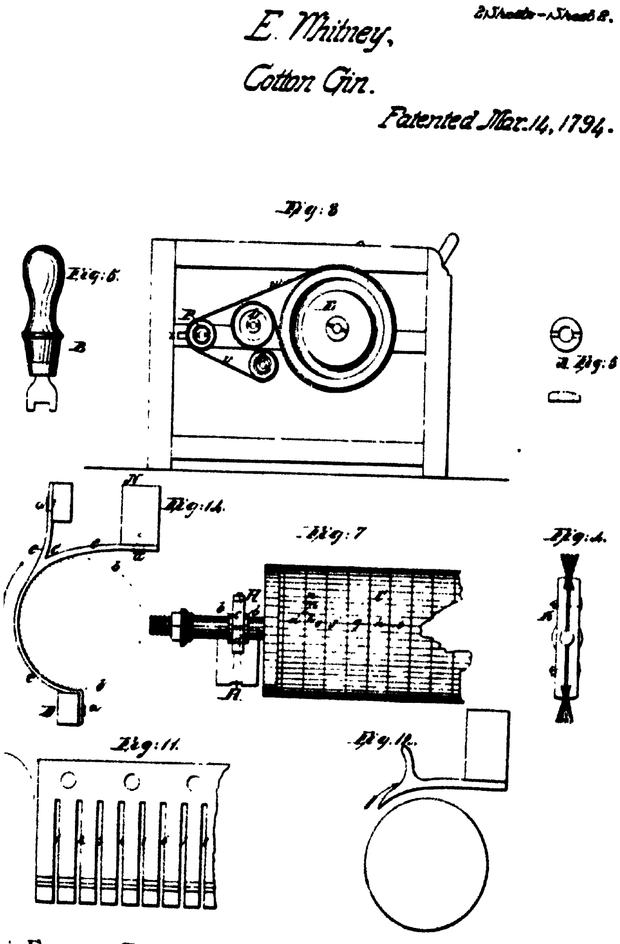


FIG. 5. Drawing Accompanying Substituted Patent.

out of sheet metal in the shape of saws. The model which would demonstrate that, was burned in the Patent Office, and has never been replaced. The records show that Holmes was not a man of collegiate education. It is natural, therefore, that his specifications, which had to be put in the inventor's own language, should not be so clear as that of Whitney, who was a Yale graduate, and who had the assistance of two Yale Professors, (Josiah Stebbins and Elizur Goodrich), in the preparation of his papers.

It is certain that Holmes was granted a patent, signed by George Washington, President, Timothy Pickering, Secretary of State and Chas. Lee, Attorney General. It is also certain that gins with saw teeth were in use about that time. In a book (Origin, Cultivation and Uses of Cotton) by W. B. Seabrook, President Agricultural Society of South Carolina, published in Charleston in 1844, the author says: "The Holmes machine was set up in the grist mill of Capt.James Kincaid on Mill Creek in Craven (now Fairfield) County, South Carolina, in 1795, and is reported to have been the first of the saw gins used in that State."

In the petition for injunction, filed in the United States Court, District of Georgia, by Whitney vs. Arthur Fort and John Powell, March 16, 1804. (For full text see Appendix, Document V.) Defendants are charged with infringements beginning 1800. In the petition occurs this language: "And it is also pretended . . . that the machine used by them contains in it an improvement; . . . that is to say, teeth, cut into circular pieces of metal."

A great deal of Whitney's correspondence has been published, in which the invention is discussed; but previous to the letter by his partner Miller to Whitney, Feb. 15, 1797, no allusion whatever is made to the saw principle. In this letter, Miller says: "It will be best to take the deposition of Goodrich and Stebbins on the subject of ratchet wheels, which may hereafter be rendered useful." The words "ratchet wheels" refer to a description often used in court in describing gin saws. This was on account of the similarity of the gin saw to the thin iron ratchet wheel used on

the end of the wooden cloth roll of a hand loom to hold the cloth taut. The full text of this letter is given in Appendix, Document VII.

The only evidence adduced to prove that Whitney invented the saw principle, is the deposition of some Yale College friends of Whitney's in New Haven, taken Nov. 7, 1807, fourteen years after the first specifications were written. These depositions were taken by commission, at whose sittings the defence (though formally notified) were not represented. These depositions are now on file among the Court records above mentioned. They are all to the effect that the saw was in Whitney's mind when he made the invention, although it was not mentioned in the specifications.

This research and discussion is not intended as an impeachment, even by insinuation of the characters of the New Haven witnesses, most of whom the records show to be men of importance and integrity; but it seems proper to call attention to the facts:

1. That they testified to matters happening 14 years previously.

2. That there were only two years intervening between the issuance of Whitney's patent describing the spiked cylinder, and the issuance of the Holmes patent for the saw cylinder.

3. That Whitney himself did at some early date make the gins with saws, and that it would naturally be hard to get the dates exact, after so long a time and at so great a distance.

4. That the memories of these witnesses were amply refreshed. In support of this last observation is adduced a letter, dated Oct. 15, 1803, from Whitney to Josiah Stebbins, one of the witnesses to whom interrogatories were addressed. In this letter, Whitney asks Stebbins to depose as follows: "I Jos. Stebbins, etc., etc., do testify and declare . . . that in the autumn of 1873 . . . that said Whitney repeatedly told me that he had originally contemplated making a whole row of teeth from one

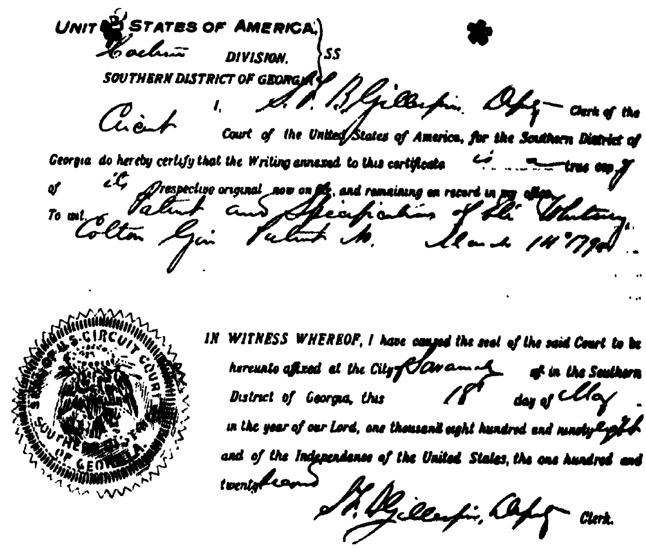
plate or piece of metal. * * * *I hope you will be able call to mind the circumstances mentioned above. * *.*"

The full text of this letter is given in Appendix, Document VIII. The fact that the depositions of most of the other witnesses examined were substantially in the language of this letter written by Whitney to Stebbins, seems to afford reasonable ground for stating that the memories of the other witnesses were similarly refreshed.

When the case versus Fort and Powell came up for final adjudication, the Court gave a decree for perpetual injunction. Prof. Olmstead quotes the text of the decree, in which occurs the following language: "A Mr. Holmes has cut teeth in plates of iron, and passed them over the cylinder. This is certainly a meritorious improvement in the mechanical process of constructing this machine + + + . Whitney may not be at liberty to use Mr. Holmes' iron plate, but certainly Mr. Holmes' improvement does not destroy Mr. Whitney's patent right."

The defence in all of the extensive litigation over the patent in Georgia, consists principally in claiming that there was a prior invention. The witnesses mostly relied upon to prove this were Dr. John Cortes Dyampert of Columbia County, Georgia, and Mr. Roger McCarthy of Chatham County, Georgia. The former swore he saw a machine "somewhere in the Domains of the King of Prussia" in 1773, used for making lint in hospitals. McCarthy swore he saw something similar in 1790 or 1791. But it developed on cross-examination, and on the introduction of numerous other witnesses, whose depositions are on file among the Court records, that these machines were on entirely different principles, and used for other purposes. There were no means of separation other than gravity in any of these machines, and they were all for beating and cleaning lint after seed had been removed.

It was finally admitted by the defence that Whitney's invention was new, but that the infringing machines were made before Whitney's model was publicly exhibited, or before it was publicly announced that he had a patent.



UNITED STATES OF AMERICA,
Eastern DIVISION. } SS
SOUTHERN DISTRICT OF GEORGIA

Circuit I, S. B. Gillespie, Acty Clerk of the Court of the United States of America, for the Southern District of Georgia do hereby certify that the Writing annexed to this certificate is a true copy of its respective original now on file, and remaining on record in my office.

To wit, Patent and Specification of Eli Whitney Cotton Gin Patent &c. March 14th 1794.

IN WITNESS WHEREOF, I have caused the seal of the said Court to be hereunto affixed at the City of Savannah in the Southern District of Georgia, this 18th day of May in the year of our Lord, one thousand eight hundred and ninety-eight and of the Independence of the United States, the one hundred and twenty-second.

S. B. Gillespie, Acty Clerk.

the frame, in such manner as to give room for the clearer on one side of it and the Hopper on the other, as in fig. 1. - Its height, if the machine is worked by hand should be about three feet four inches: otherwise it may be

Fig. 6.

Certification of Whitney Patents, etc., showing few lines of the document attached.

Full Text in Appendix, Document II

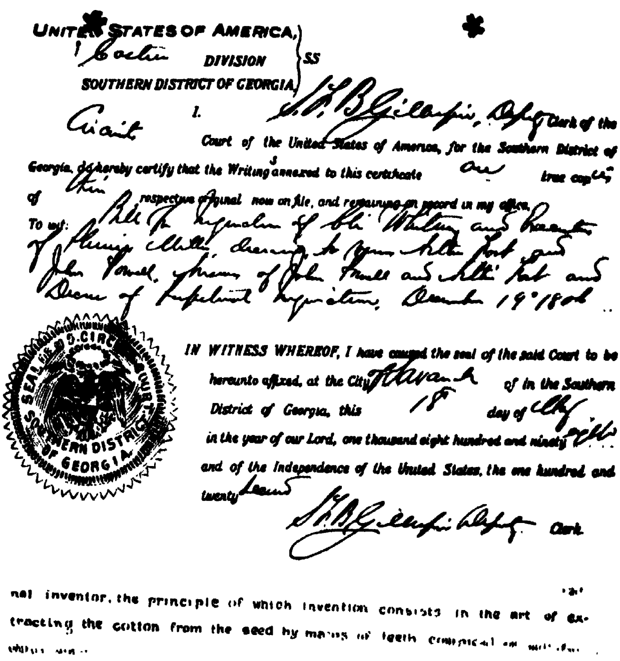
See Fort's answer in Whitney vs. Fort and Powell, U. S. Court, District of Georgia, Dec. 17, 1805, Appendix, Document V.

There is a widespread allegation that "Whitney was badly treated in the South." This seems to rest on the rumor that his first model was stolen from his shop at Mulberry Grove, Ga., that copies of it were widely made and used without license, that his witnesses failed to appear at the trials, that the South Carolina legislature after agreeing to pay him for the patent, afterward rescinded its action; and finally that there was a conspiracy among the cotton planters to invalidate his patent.

As to the burglary of Whitney's shop, and stealing of his models, there is not a word in the voluminous records of evidence in the infringement suits, extending over 13 years. Neither is any mention made of it in his published correspondence. This seems conclusive proof that the story is of subsequent and spurious origin.

The facts regarding Whitney's experiences with the legislature of South Carolina, have been carefully investigated, and an abstract of the State House Records on this subject is given in the Appendix, Document IX.

An examination of these papers shows that Dec. 10, 1801, at the close of the session, the legislature passed a bill purchasing the Whitney patent right for the State for $50,000, agreeing to pay $20,000 in cash, and the remainder in three equal annual installments, provided Whitney would make "within a reasonable time" two models of his gin, in his very best style, and file them for public inspection in the State capitol, and provided further, that Whitney should refund all the amounts previously collected for license in the State. The cash payment was promptly made. But Whitney did not, within two years comply with either requirement. The legislature in 1803 declared the contract forfeited, and provided for entering suit for the recovery of the first payment. This action brought the final fulfillment of the conditions on the part of Whitney, in 1804, and then the legislature of 1804 ordered the



UNITED STATES OF AMERICA,
Eastern DIVISION } SS
SOUTHERN DISTRICT OF GEORGIA

I, S. P. B. Gillespie, Depty Clerk of the Circuit Court of the United States of America, for the Southern District of Georgia, do hereby certify that the Writings annexed to this certificate are true copies of their respective original now on file, and remaining on record in my office.

To wit: Bill for Injunction of Eli Whitney and Phineas Miller, deceased, to John Powell, Answer of John Powell and Order ... and Decree of Perpetual Injunction, December 19 1806.

IN WITNESS WHEREOF, I have caused the seal of the said Court to be hereunto affixed, at the City of Savannah in the Southern District of Georgia, this 18 day of Oct., in the year of our Lord, one thousand eight hundred and ninety-seven and of the Independence of the United States, the one hundred and twenty-second.

S. P. B. Gillespie Depty Clerk.

nal inventor, the principle of which invention consists in the art of extracting the cotton from the seed by means of teeth ...

Fig. 7.

Certification of Bill of Injunction by Deputy Clerk U. S. Court, showing few lines of Document attached.

Full Text in Appendix, Document V.

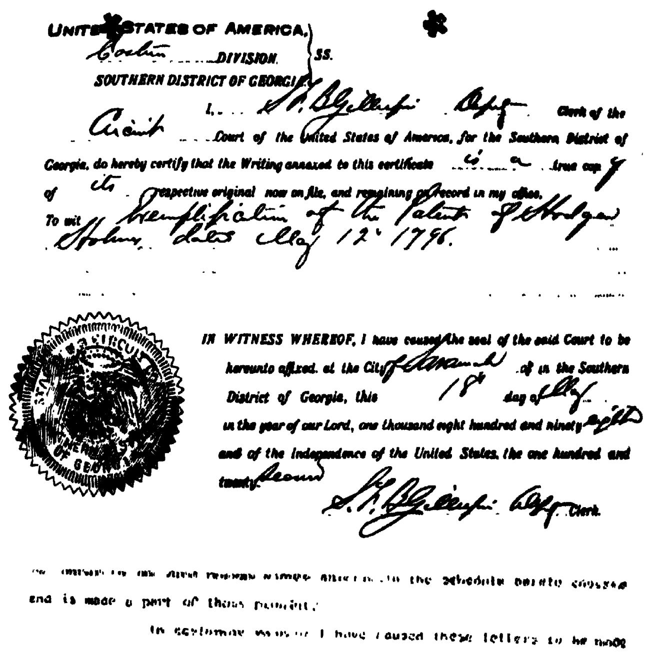
suit discontinued and reinstated the contract in accordance with which the deferred payments were promptly made.

The legislature of North Carolina in December, 1802, bought the patent right for that State, and agreed to pay for it by a special tax of 2 shillings and six pence on each saw used in a gin within the State for four years. This tax was properly collected and turned over to the inventor, amounting to about thirty thousand dollars.

Whitney's plan in Georgia, as shown by his letters and other evidence was to own all the gins and gin all the cotton made in the country. It is but human nature that this sort of monopoly should be odious to any community; and when to this is added the fact, (as shown by letters to Whitney in Connecticut, from his partner Miller in Georgia) that Whitney and Miller could not supply the demand for gins, it seems natural that there should have been much infringement. After the gins were introduced in 1794, there was a large cotton crop made for the next season, on the presumption that it could be prepared for the market on the new machines. But when the crop was gathered,, and the gins were not forthcoming, many planters had rude gins made in their own blacksmith shops. From this circumstance, arose the rumors that the various workmen who made the gins were the original inventors. One of the traditions crediting the invention to Jesse Bull of Columbia County, Ga, (afterwards of La-Grange, Ga.,) arose from the circumstance of a gin having been made for Bull by one of his employees, Nathan Lyons. It is said that when the first Whitney gins were in use in the country, no one but women were allowed to see them, and that Nathan Lyons, disguised as a woman, saw the gin and copied it.

This legendary story has no authentic foundation. The voluminous evidence in the infringement suits nowhere refers to such an incident.

Quite a number of legends about the invention of the gin have no foundation whatever in fact. For example, the



UNITED STATES OF AMERICA,
Eastern DIVISION. SS.
SOUTHERN DISTRICT OF GEORGIA.

I, S. P. B. Gillespie Dep'y Clerk of the Circuit Court of the United States of America, for the Southern District of Georgia, do hereby certify that the Writing annexed to this certificate is a true copy of its respective original now on file, and remaining of record in my office.

To wit: Exemplification of the Patent of Hodgen Holmes, dated May 12th 1796.

IN WITNESS WHEREOF, I have caused the seal of the said Court to be hereunto affixed, at the City of Savannah, in the Southern District of Georgia, this 18th day of May in the year of our Lord, one thousand eight hundred and ninety eight and of the Independence of the United States, the one hundred and twenty second.

S. P. B. Gillespie Dep'y Clerk.

Fig. 8.

Certification of Holmes' Patent by Deputy Clerk, U. S. Court, showing few lines of document attached.

Full Text in Appendix, Document VI.

pleasant little story about the gin brush being suggested by the lady with her turkey tail fan.

Holmes became a successful and prosperous planter. His descendents are numerous in South Carolina and Georgia, and are people of high social standing.

The real facts about the cotton gin are:

1. Eli Whitney, of Mass., a graduate of Yale College, invented a cotton gin, consisting of spikes driven in a wooden cylinder, and having a slotted bar through which these spiked teeth passed, and having a brush to clear the spikes. He obtained a patent March 14, 1794, signed by George Washington, President, Edmund Randolph, Secretary of State, and Wm. Bradford, Attorney General.

2. Hodgen Holmes, of Georgia, a resourceful and practical mechanic, invented an improved gin, using circular saws properly spaced, passing through spaces between ribs. For this invention he obtained a patent May 12, 1796, signed by George Washington, President, Timothy Pickering, Secretary of State, and Chas. Lee, Attorney General.

3. Whitney's invention, consisting of a wooden cylinder, carrying annular rows of wire spikes, with a slotted bar and clearing brush was fundamental.

4. The practical application of the fundamental idea was Holmes' invention of the saw gin, which consisted of a mandrel or shaft carrying collars separating circular saws which pass through narrow spaces between ribs.

5. Whitney went South without money, business experience or mechanical training. He received from the Southern States the following amounts:

From South Carolina	$50,000
From North Carolina, (at least)	30,000
From Tennessee, (about)	10,000
Royalties from Southern States........$90,000	

6. In Georgia, his firm (Miller & Whitney) attempted to monopolize the ginning business. This brought on long and vexatious litigation, and the object was never successfully accomplished.

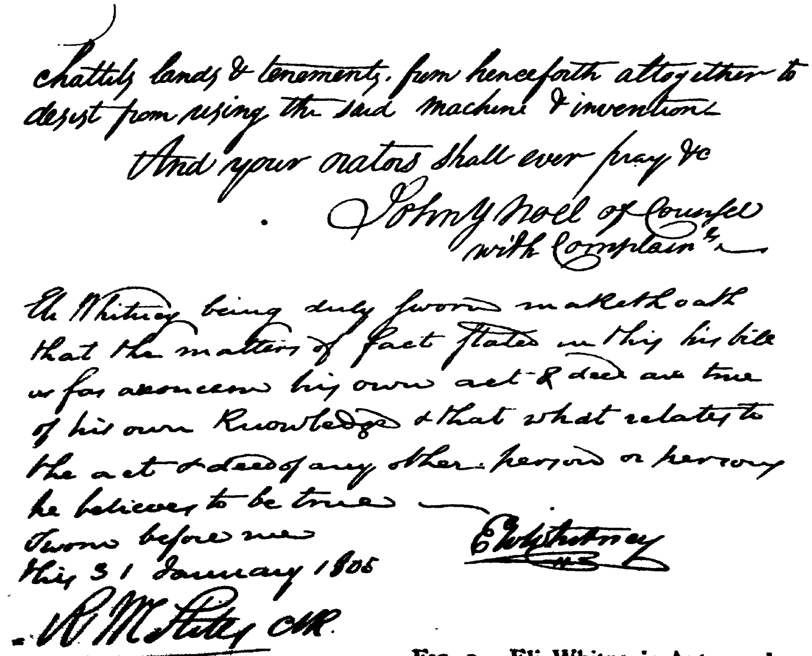

chattels lands & tenements, from henceforth altogether to
desist from using the said machine & inventions
And your orators shall ever pray &c
John Y Noel of Counsell
with Complain^ts
Eli Whitney being duly sworn maketh oath
that the matters of fact stated in this his bill
so far as concern his own act & deed are true
of his own knowledge & that what relates to
the act & deed of any other person or persons
he believes to be true
E Whitney
Sworn before me
this 31 January 1806
R M Stites CM

FIG. 9. Eli Whitney's Autograph.

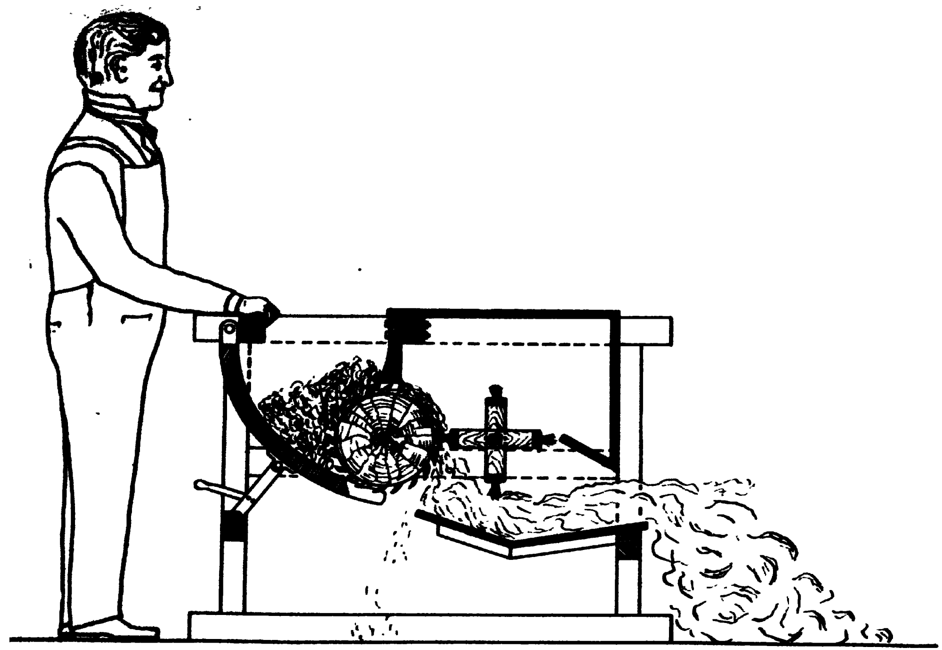


FIG 10. Whitney's Spike Gin, Intermittent Action.

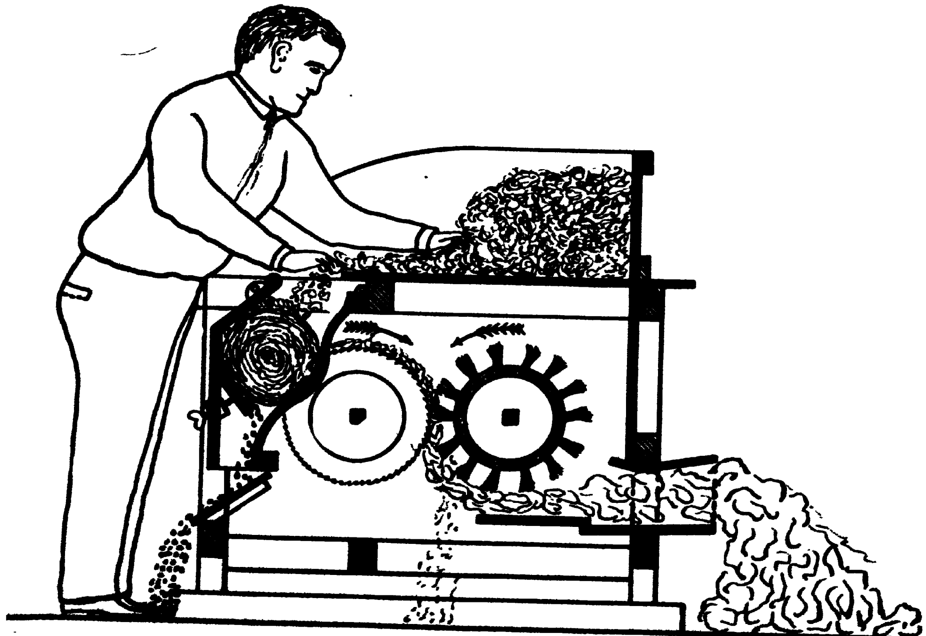


FIG. 11. Holmes' Saw Gin, Continuous Action.

CHAPTER III.

The Preparation of Cotton for the Market With Slave Labor.

After the invention of the cotton gin, a plan of structure was soon developed for the storage of cotton, and in which the separation of the cotton from the seed was accomplished by the new machine. Generally, whoever bought one, built a house in which to place and use it, the house being so arranged as to cover the necessary machinery to operate the gin by power from two or four mules or horses. Accompanying this structure, there was usually a large press, the principal feature of which was a large wooden screw. This press was for packing the lint cotton into bales. The main building, above referred to, was called the gin house. The press, taking its name from its principal member, was called the screw, (possibly originally screw press).

As these structures were developed in the early days of cotton raising, so their shape and appearance remained, generally speaking, much like the original patterns until 1875 to 1880. Up to that period it may be said that no improvement of any consequence had been made, and even at that period, few plantations were without the old style gin house and screw; though in many cases the horse power had been supplanted by a small steam engine.

The requirements were as follows:

1. A place to store the seed cotton as it was gathered from the field.

2. A suitable place for the operation of the gin.

3. A lint room to receive the cotton as it came from the gin.

4. A lint room to receive the lint cotton for temporary storage while waiting to be packed.

FIG. 12. Old Plantation Gin House and Screw.

5. A place for the "running gear" or driving apparatus, so located that horse or mule power could be applied and be under shelter.

The arrangement most common, and almost uniform, was a one and a half or two story building in which the main part of the the lower story was left without floor or sides, except where the side of the lint room adjoined it, as shown in Fig. 12. It was practically a building set up on wood pillars or columns, braced to make it firm and steady. The gin was placed in the second story, called the gin room; but this was always made large enough to serve as a store room for seed cotton as it was brought in from the field by the pickers.

The gin discharged lint cotton into an upper lint room. This lint would be thrown down by hand through a door into a second lint room, adjoining it, and reaching down nearly to the ground. Here it would be trampled down to save room, while waiting to be carried out to the press.

In the open space under the gin floor, was a vertical wooden shaft with long levers passing through it at a proper height from the the ground for hitching the mules. On this vertical shaft, above the levers, was a large wooden cog wheel, eight to ten feet in diameter. The cogs were made of hickory, and were mortised into the wooden rim. These meshed with the "wallowers" or "wabblers", set into the circumference of a horizontal shaft, which turned in wooden hangers suspended from the beams of the upper floor, as shown in Fig. 13. On this horizontal shaft was a plain wooden pulley six or eight feet in diameter, and from which, by means of a belt, the gin was driven. On the saw shaft of the gin was an eight- to twelve-inch pulley which received the belt from the driving pulley. It was desired to drive the gin at the rate of 200 to 300 revolutions per minute. These wooden cog wheels and pulleys, clumsy as they were, were usually preferable to castings, because the first cost was much less, and the necessary skill and material were

both available to keep them in repair, neither the labor nor material costing anything.

After the cotton was ginned it became necessary to put it into some kind of a package for the market. In the earlier gin houses there was a circular hole cut through the upper floor, probably three to three and one-half feet in diameter. Through this hole a large sack was suspended. The lint cotton was packed into this by hand, making for the market what was called a "bag of cotton." (Among old people at the present time, this term survives as a designation for a bale of cotton, of any kind.) It afterwards became desirable to make bales 5 to 5½ feet long, about 30 inches thick, and 40 to 48 inches wide, weighing 400 to 500 pounds. This grew to be the standard size and shape of the bale. It was the result of the conditions surrounding the plantation. The body of the wagon, in which the bales must be taken to market, held four of them neatly. When it was desired to haul more than four bales, others could be loaded cross-wise and on top of the four in the body of the wagon; then, still others on top of these, or as shown in Fig. 14. Ten bales was usually the limit of the load for a team of six mules. It was thus that most of the cotton was sent to market. Such a load was rather top-heavy, and the bales were in some cases bound to the wagon by a pole passing over them from front to rear which was tied down at each end by means of ropes, to the body or the frame of the wagon. Topmost of all for long trips, was an arch frame, made of bent wood and covered with canvass, under which corn, fodder and food was stored for the trip.

Much cotton was hauled in loads of this kind a distance of fifty, and even one hundred and fifty miles. From the large plantations two or three such loads would be sent together. No fault was ever found with the size or weight of the bales. It rarely happened that there was less than twice the force at hand to do anything ordinarily required to be done in the way of handling cotton. Much

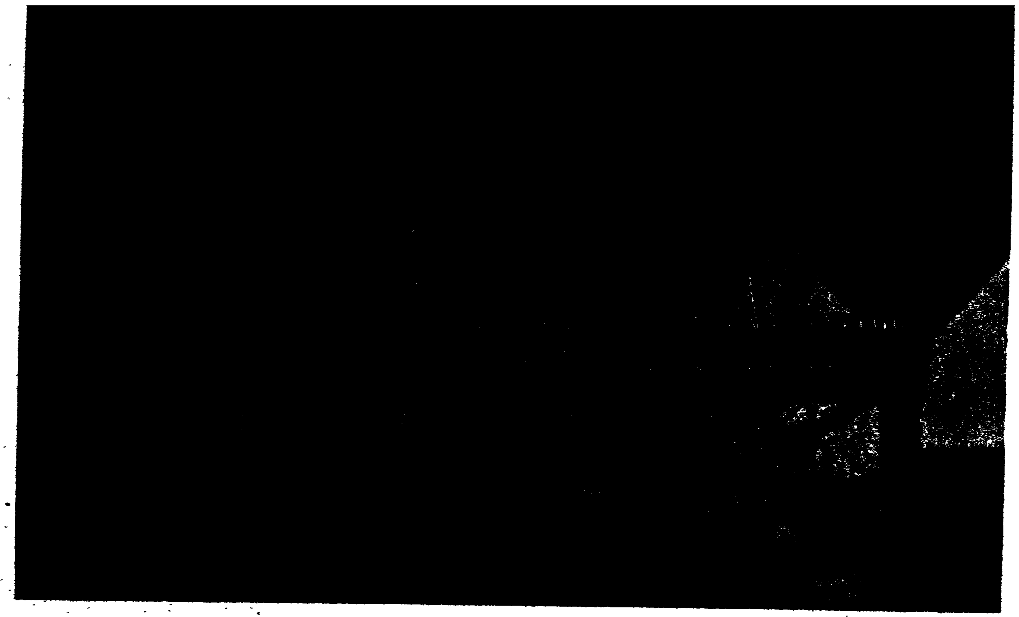


Fig. 13. Old Horse Power for Gin House.

of the humanity on a plantation was usually present to help load and fit out the wagons for a trip to the market town, and a whole day would frequently be devoted to loading and preparing. The "gear" must be overhauled. (Mules were usually driven in "gear," not harness. A set of gear consists of a collar made of shucks or poplar bark, a pair of hames, a hame-string, two trace chains and a back band.) The wagon cover often required patching and the carpenter and smith must tighten nuts, put in new bolts, and do such other repairs as seemed to them necessary to insure a safe trip. The season of hauling cotton generally brought bad weather, and the heavy travel of the cotton wagons would cause bad roads to be the rule. There was a fellow feeling amongst the wagoners on the road, and they helped each other out of mires, up steep hills, and in cases of overturning.

Everything being in readiness, an early start was usually made from the plantation. Plenty of extra help was always on hand, and besides the wagoner for each team, and perhaps a couple of helpers for each, several other stout hands would go, three, five and even fifteen miles, and then return home.

The delight of the planter's young sons, twelve to sixteen years old, was to be allowed to accompany these wagons to market. The trip required three to six days, and even longer. When the sons would go, they would camp out with the negroes, live on the same fare, and often the members of the party would have a little "'possum hunt" after camp was struck at night.

It was by this sort of contact and fellowship with the negroes that the planter's son acquired that exact knowledge of the negroes' character which qualified him subsequently to control them on the plantation. Much of this fellowship of the planter's son with the negroes would now be considered coarse. Most of his sports of that time were rough, but both these conditions contributed to the stimulation of the spirit of aristocracy.

If the mistress or young ladies should go, it was in the heavy carriage peculiar to the time and section. The planter himself would be on horseback or in an open buggy with a servant.

The abundance of help to handle them, and these cumbrous trips, in which heavy single bales remained best on the wagons, made the weight, shape and size of the bale which was made under the screw the most desirable, and therefore it was that the screw was designed to make them.

The necessary quantity of cotton to make a bale could be packed by the weight of two men into a box with dimensions equal to the length and thickness of the bale and about nine feet high. To press this down to the forty inches was the work of the screw. A heavy frame was made containing the box as described. See Fig. 29. This frame extended above the box and held a large nut made of four massive blocks of timber firmly pinned together. Through this wooden nut passed a large wooden screw, cut out of a log 14 to 16 inches in diameter, and with threads about four inches broad or eight and one-half inches pitch, fitting in similar threads in the nut. To be able to lay out and cut the threads in this screw and nut, and have them fit properly and work well was the test of a plantation mechanic's ability as a mill-wright and carpenter. From the upper end of this screw, long sloping leversextended very nearly to the groundwhen the screw was down, and to these levers, mules were hitched and driven around to pull the screw up and down in packing the bale.

Proper sheds were put about the lower part of the structure, and on the top of the screw and levers, to protect the structure and the operatives from the weather.

The screw was entirely separate from the gin house, and the lint cotton had to be carried in hamper baskets, from the lint room to the screw. See Fig. 12.

For the purpose of ginning and packing cotton with

Fig. 14. Hauling Cotton to Market.

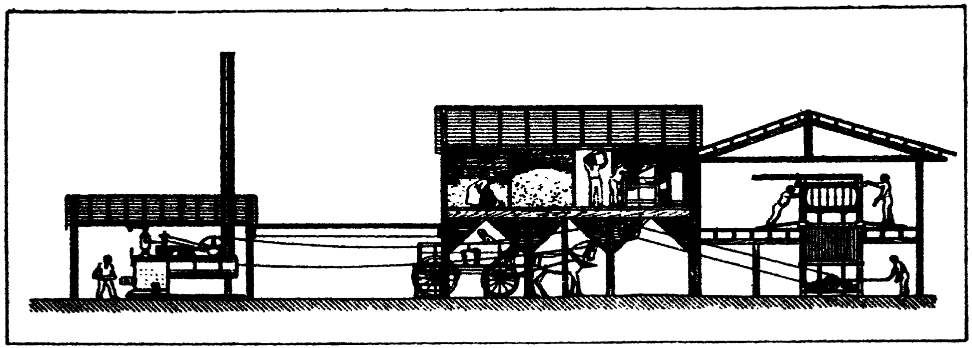


FIG. 15.

Steam Power Applied to Old Gin House.

the above facilities and appliances, there were generally required: Four mules to operate the gin, (two at each lever under the gin house); two drivers under the gin house; in the story above, a ginner to stand at the gin and feed the cotton into it properly; a ginner's helper to supply the cotton to the ginner at the gin; a helper to push the lint from the gin into the lint room, and a man or a boy to remove the seed from the floor under the gin; two hands to carry cotton from the lint room to the screw; two hands in the box to pack the cotton down to make the box hold a bale; one or two mules to pull the screw and one or two drivers. In all, eleven hands, and frequently as many more were "helping" around the gin house and screw on rainy days. If there was a breakdown, most of the hands loitered about on piles of cotton or seed, while a few would help the carpenter or blacksmith to repair the breaks. To gin and pack two or three bales a day was fair work for the above force. The bales were partially enclosed in jute bagging and bound with rope.

From the time of the invention of the gin to the close of the Civil War, when slavery was abolished, there was no demand for methods and appliances other than those above described. Steam power would have brought responsibility with no commensurate advantages from the planter's point of view. The boiler might explode, and if it did, the smallest part of the loss would have been the engine and boiler. Two or more thousand dollars worth of negroes might be killed, and perhaps many more wounded. This would make large doctor bills, and labor and attention to nurse them. The special care of the sick was the most particular personal care of the humane planter. Then, too, a steam engine would be getting out of order, repairs would have to be obtained from machine shops, which were few and often far distant. In fact, the planter himself would have to give it some attention, even if he had an ordinary overseer; and the planter had little taste for anything that would require his attention except the care and government of the humanity on his plantation.

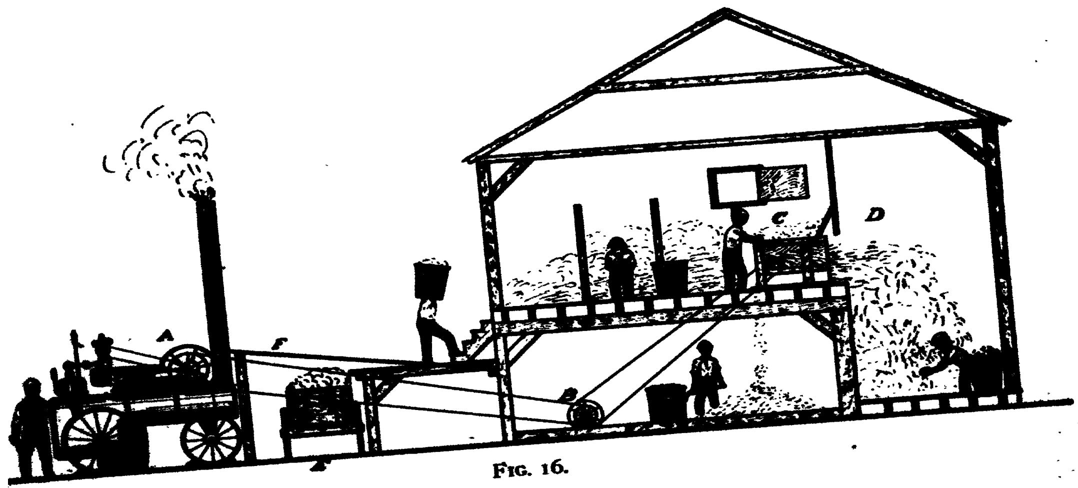


Fig. 16.

Early Steam Ginnery.

ARAB-AFRICAN:

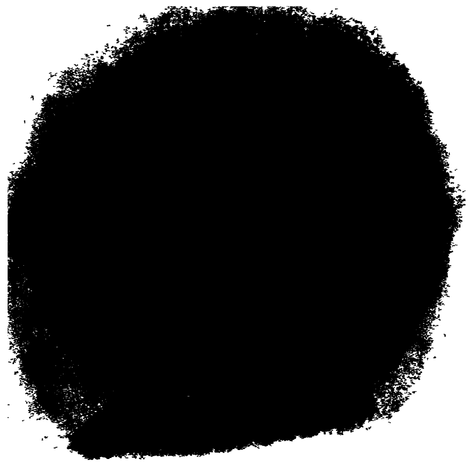
BUTLERS, BODY SERVANTS AND MECHANICS.

***FROM NORTHEAST COAST.*—Color, dark bronze to red gold. Straight nose, thin lips and woolly hair. Women very handsome. Arabs ally themselves with this type as an equal.**

SARACEN-AFRICAN:

PREACHERS, MECHANICS AND FARM LABORERS.

***FROM HIGHLANDS OF MIDDLE AFRICA.*—Color, dark bronze. High forehead, woolly hair.**



DINKA-NEGRO:

HOUSE SERVANTS AND FARM LABORERS. THE "MAMMY" WAS USUALLY FROM THIS TYPE.

PASTORAL PEOPLE FROM UPPER AND MIDDLE NILE.—"Strikingly long and lean," predominantly dark, with shading toward gray.

GUINEA-NEGRO:

FARM LABORERS.

WEST COAST.—Color Black. Flat nose, thick lips, receding forehead, kinky hair. With savage and cannibal instincts. Colloquially known as "Blue-Gum Nigger."

CHAPTER IV.

The Plantation Before the War.

Any discussion of Southern plantation conditions before the Civil War, must of necessity, be intimately related to the institution of slavery, and be coupled with the study of the negro himself.

The Negro Slave.

Measured by Anglo-Saxon standards, a low type of uneducated negro is one bundle of contradictions. He can sleep more and get along with less sleep, eat more and get along with less to eat than ordinary humanity. In honesty and dishonesty, in strong affections and violent bad passions, in splendid loyalty and savage disloyalty, his moods often moving with rapidity from one extreme to the other in all these human motives, he is governed by his immediate surroundings and influences.

It is totally at variance with Anglo-Saxon character to live in absolute subjection and yet love the master. The life on the plantation was one of absolute mastership on one side and of absolute subjection on the other, with the easiest sort of personal intercourse between the two, and affection on both sides.

In this statement is contained a fundamental difference in the characters of the white man and the negro, which can never be appreciated except by those who have had intimate contact with the negro race. It is the lack of appreciation of this difference which made outside Anglo-Saxon plans of reconstruction bring such confusion instead of order, out of the disorders of the Civil War.

The white man loves to control, and loves the person willing to be controlled by him. The negro readily submits to the master hand, admires and even loves it. Left to his own resources and free to act as his mind or emo-

tions dictate, no man can foresay what he is liable to do. He may move under the influence of high motives and impulses, or of savage passions. All this relates to the slave and to the freedman without education or training.

The so-called race problem is not one, of the relations of a single white race with a single negro race, but rather one of a number of white races with a number of negro races.

The negro population of the United States is probably as much mixed as the white population. When the slave trade was in full operation, some of the negroes brought over were absolute savages, while others enjoyed a considerable degree of civilization. The best and the worst were probably 1,000 years apart in civilization, while yet in their home in Africa. The highest types were perhaps those from the interior of Africa, who had developed a fair civilization and were seldom enslaved. The lowest type was undoubtedly the West Coast Guinea negro, who was not only a savage, but the lowest type of Cannibal. On the Red Sea shore, near Arabia, there developed tribes of possibly higher civilization than those in Central Africa. Amongst the negroes themselves in the South, these differences are known and frequently referred to. The "blue-gum nigger," means the descendant of a west coast Cannibal type, while "the Dinka," is the superior type. Other negroes believe that the bite of a "blue-gum nigger" is deadly poison.

The better types have many fine qualities of character and sometimes amongst them are individuals of rare intellect, and even princely characteristics of mind and manners. But, as in India, the highest of the princes yield and defer to practical English thought, so in America, the African of high type defers to and promotes the civilization of the white man of composite Caucassian blood, (English, German, etc.), while the inferior types stand in wholesome awe only of the force with which the white man is known to insist upon as punishment for those who violate his civilization.

Much the larger portion of the negroes caught and brought to this country by slave traders were naturally the inferior types.

The descendants of the better types travel most, and are servants about hotels and private houses, both North and South.

The redemption of the negro race from a condition of backwardness and unequal development may be accomplished by education. This is made to appear doubtful in many cases, where education has been seen to emphasize indolent or vicious qualities in many of them. On the other hand, there are many examples in which better opportunities and education have brought the qualities of good citizenship to fair development, and in exceptional cases to remarkably high standards.

Civilization destroyed a large majority of the Indians. It is now said that the remnant yet left is the civilizable remnant. It is claimed that these are now improving in numbers and in qualities of civilization. It is possible that civilization will do with the negro, in a different degree, what it did with the Indian, viz: destroy the inferior and uncivilizable percentage and civilize the better element.

It transpires that the leaders of the race itself seem capable of the best work in formulating plans for the elevation of the race by education. These have been happy in their judgment of what sort of education best suited the negro in his present conditions and surroundings. These strongly urge that the negro must rise by degrees, going through each condition of progress already passed by the white race; and that the education now most required for them is that practical sort, which makes them artisans, (carpenters, bricklayers, blacksmiths) and skilled workers in other trades, and better and more intelligent agriculturalists.

The ultimate result would seem to rest principally with the race itself.

The planter, living on his plantation, was always at hand to put a stop to any sort of disturbance. The influence of the planter's family was of greater importance than was ever appreciated in keeping the better natures of the negroes to the fore. A very generous and friendly kindness has an immense and far-reaching influ-

ence. The white boy or white girl of slave-holding families was to them something just a little more than ordinary humanity, and thus they could exercise an authority and an influence almost incomprehensible. These peculiar relations were not without influence on the white race. The control was not alone by force. The example of perfect conduct was important in two particulars. These were physical courage, and the keeping of one's word. The negroes admired the man who was afraid of nothing, and who never failed in his promises. Therefore, the qualities of courage and truthfulness became highly developed; and to question either of these in any planter meant mortal combat or disgrace. Thus came the frequency of the duel in the South, though it was never so frequent as has been supposed.

Many people who were opposed to the institution of slavery have been persistent in representing the planter as a furious fighter or "fire-eater." Frequent dueling seemed to confirm this reputation.

As a matter of fact, the average planter, while amply courageous, was the most amiable, friendly, hospitable and unagressive of men. He was slow to take or give offense. He never carried a pistol, or otherwise went prepared for a fight. When he felt himself offended by an inferior, he inflicted an ordinary chastisement, and it was dangerous for the inferior to resist it. When his veracity or courage was questioned by an equal, there was a well formulated "Code Duello," printed in book form, in accordance with all the regulations of which, he must as a gentleman proceed. These required most ceremonial notices and preparations, also the attendance of friends on each side, to guarantee absolute fairness. It required high character and courage to live under and up to the Code.

Slavery and the habit of duelling were the two blots on the civilization of the South. The former frequently developed inhuman masters, and the latter occasionally developed fighting bullies—the professional duelists. The great majority of planters were neither inhuman masters nor

professional duelists, but were essentially the kind of men respected and beloved of humanity.

Among many other changes brought about in the cotton producing area of the South, is the total disappearance of the sentiment in favor of, or the reason for the tolerance of the duel. One of the most grotesque absurdities of the present day is the fool who poses as being willing to fight a duel, laboring under the delusion that he is imitating his grandfather. The courage of the best type of planter was never manifested in common fighting, and among his worthy descendants, the duel is equally in disrepute.

The idea that the ante-bellum cotton planter was indolent, or an indifferent business man, or that he was always a spendthrift is totally wrong. On the contrary, he was ever on the alert. He was judicial minded, energetic, usually well educated, always well trained in every operation connected with the production of standard crops. He succeeded by the same means that are necessary for success now, viz. by better education, better training, more energy and steadiness of purpose, than the average of the people who do not succeed so well.

The system of agriculture operated by the planter was wonderfully successful. Besides developing the production of cotton to an extent to give the world better, cheaper and more abundant raw material for clothing than ever before enjoyed, he at the same time, and in addition, produced more grain per capita, more meat per capita, and more home supplies, than the people of any other part of the United States. The methods of organization, and of training the organizations were unsurpassed. Influences adverse to education of labor, and favorable to the institution of slavery, ultimately destroyed a system that was in other respects most excellent, and wonderfully successful.

Great improvement in the condition of Southern agriculture is being brought about by diversification of crops, even in sections that have as yet no manufacturing population. It has been pointed out that the ante-bellum Southern planter of cotton raised practically all his supplies at home. The

post-bellum farmer has not been doing this; but he is coming more and more to it, and is prospering in proportion. Although population is largely increased in each cotton planting State, none of them (Texas excluded) are even now raising as much corn, meat or wheat as they did in 1860.

Plantation Profits.

The planter who produced cotton with slave labor could always make money. Of course, this varied greatly. Some would make more and some less, and some would fail, without regard to the price of cotton. Even at 4c a pound, a planter who was energetic and had good judgment, could make from 8 to 10 per cent. on his investment. This certainty of profit was entirely due to the fact that the support or living for all the humanity on the plantation was produced on the plantation.

The crop was generally laid out on a basis of 25 acres to one good hand and one mule. Of this land, 10 acres would generally be put in cotton, and 15 in wheat, corn and oats. The most able bodied men on the place were generally the plow hands. About one-half the labor was selected for this purpose. The older men, the strongest women and the youths on the place made another force of labor that did the hoeing, handling of the grain, picking the cotton and all miscellaneous work.

Of course, the work of the able bodied men was not confined to plowing. In season, some of them did the blacksmithing, clearing land, driving wagons, ginning and hauling cotton to market. In fact, there were no such formulated divisions, such as is above indicated, but the work of all the hands was subject to much variation. In much of the work, all kinds of labor took some part; and in such work as hog-killing and sheep-shearing, even the children would like to be about and take a hand.

A good planter could operate his plantation in such a way as to have practically the entire cotton crop as clear profit. This would, of course, mean that live stock, grain

and other products of the plantation, beside cotton, would be sold in sufficient quantity to yield money to buy clothes, sugar, coffee, molasses and other necessary family and plantation supplies which could not be raised on the plantation.

Extent of Plantations.

Some plantations comprised as high as ten to twenty thousand acres of land, and one thousand slaves. These were comparatively few, and the entire investments in such a plantation would have been about one million dollars. On the other hand, there were a great many instances of small cotton planters owning ten or less slaves, and 300 or less acres of land.

The capital in such cases would not exceed eight to ten thousand dollars.

The great bulk of the cotton was produced by planters who owned from 50 to 150 slaves and 2,000 to 5,000 acres of land. It was this great class that made their plantation supplies on the plantation, and made cotton growing a great institution.

Taking the average plantation at one hundred slaves and 3,000 acres of land, the equipment would be as follows:

25 plow hands,
25 miscellaneous hands,
50 women and children, non-producers,
25 mules,
4 horses for family and general use,
600 hogs,
25 head cattle,
100 sheep,
10 goats,
15 dogs.

Chickens, guineas, peacocks, turkeys, geese, ducks, etc.

Blacksmith shop, wheelwright and other wood-working shop, 20 to 25 negro houses, gin house and screw,

stables, barns, carriage houses and wagon sheds, and in many instances, a grist and flour mill, and a store.

Such an average plantation of 100 slaves and 3,000 acres of land, with its equipment, would be worth on an average about $100,000. It would produce about 100 bales of cotton, besides all supplies. Such a plantation, conducted with energy and good judgment, woud easily make $10,000 to $20,000 a year, according to management and the price of cotton.

The query as to a man's wealth was not "how much is he worth?" but "how many negroes does he own?"

Some planters were thrifty and economical, and grew richer with great rapidity, while many employed overseers to look after their estates, and spent the incomes in travel or local extravagance.

The Plantation Home.

It was the custom for the planter to live on his plantation. Even those who traveled much had a home on the plantation, and spent much time there. The maintenance of the organization of the plantation and labor, and the control of the negroes as slaves, made it practically necessary for the planter and his family to live on the place This left plenty of time on the hands of each member of the family. In this condition the plantation home was always a hospitable place. Besides ample time, the host and his family hadabundant service, horses, vehicles, plenty of home raised food, excellent cooks, and plenty of amusement, such as hunting and fishing for the men, and dancing for the young people. Even the music was made by a slave who had learned the violin. (Negroes were fond of music, and many of them learned to play different instruments.) There was no cumpulsion in such cases—none was ever necessary. The slightest suggestion by a young lady from the "big house," would bring the tender of services from every one on the place who could play the fiddle. Besides being fond of music, the negroes were ex-

Fig. 17. Spinning Wheel.

ceedingly fond of the gayety and finery of dances and other functions. Indeed, whenever the company and the home folks furnished young people enough to make a quadrille or Virginia reel, the first suggestion of the dance would be apt to come from some negro, who wished to see the fine people and dresses in the rhythmic evolutions. Then, too, fiddling in the big house at night for the young white folks, was an acceptable excuse for being late at work in the morning. At all entertainments the "field hands" (negroes who had not access to the house as servants or otherwise,) would crowd around the windows and porches to look on, as they were always welcome to do. The pleased expression on the faces of all these. and many other evidences showed that, to them, to watch the dancing or other proceedings was great entertainment. On such occasions, it was not uncommon to see a young lady in the dance, when near a window, divide her attention and conversation between the young man who was her partner, and some negro woman on the outside, who was one of her slave friends.

The publicity of all plantation life was training for the young men, and accustomed them to live in public view as it were, and contributed to make public speakers and statesmen.

Previous to about 1845, most of the negro houses were log cabins, and the houses of many planters were also built of logs. After 1845, most of the houses for both planter and slave were frame, those for the planter being usually large and pretentious, while those for the slaves were of about the same character as tenement houses built about the same time for factory operatives in the North and East.

The log house was usually covered with what were locally known as "boards." These were 2½ to 3 feet long, and about 6 inches wide. They were riven or split out of logs, as shingles are, but were not drawn as shingles were then.

(Shingles were "drawn" smooth and tapering with a "drawing knife.") Frame houses were generally covered with shingles.

General Organization.

The average well regulated plantation was almost always in the immediate charge of the owner. If the owner was a professional man, lawyer, doctor or preacher, there was generally an overseer. Many planters who were not professional men also had overseers. These overseers had general charge of the labor. They blew a horn or rang a bell in the morning to call out the negroes to work, and otherwise looked after their labors in detail. The pay of the overseer was usually three to five hundred dollars a year, a house to live in, a good horse to ride, and some part of his living out of the products of the plantation. It was he who flogged the slaves, when this was considered necessary.

There were generally on every plantation a carpenter and millwright, and a blacksmith. Wagons had wood axles and were lubricated with pine tar. This pine tar was made in a "tar kiln." Charcoal was used in the smith shop. This was made in a coal kiln. Collars for mules were made of corn shucks or poplar bark. Hogs, cattle, sheep and goats to make the meat supply were raised on the place. Much cotton and wool was spun at home, and not a little also woven. Frequently wool would be exchanged with some factory for cloth.

The planter's wife would overlook the weaving and the making of the negroes' clothes, while most of the work was done by the negro women.

Planters' wives and daughters combined in a curious way aristocratic ideas and habits with practical capabilities. While, as a rule, they rarely worked much, they nevertheless learned every domestic operation and duty, and could direct these with wonderful understanding and efficiency. Practically all

Fig. 18. Portable Ginnery.

ladies learned to ride horseback, and to handle horses, not only easily, but so well as to make it a real pleasure. A young lady on a plantation would think nothing of having her horse saddled and riding ten miles in an afternoon to pay a visit, riding home the same afternoon.

Much of the plantation work was turned into a frolic. In the autumn when the corn was gathered, many planters would have it piled on the ground before the doors of the corn cribs, and then give a "corn-shucking." Everybody on the place would be at the shucking, as would also negroes from neighboring plantations. Frequently many white people would be invited, and while these would do no work, both whites and blacks would have a big frolic. The function was generally on a moonlight night. There was liquor, mostly corn whiskey, while the shucking was going on, and a supper afterwards. Perhaps a shote or calf would be killed and barbecued. One negro would be selected to get on top of the corn pile and lead in the singing, and the singing was a sort of solo refrain by this one leader, and some chorus answer by all the others. Meanwhile the white folks would talk politics and hobnob in the big house.

When new ground was to be cleared, the home folks cut down the trees, cut off the brush, piled it, and when dry, burned it; and then, to get rid of the heavy logs, laid a plan to get them piled up and burned. Neighbors were again invited to help roll the logs into piles. This was called a "log-rolling," which was a daylight function. The social features of liquor, dinner and politics were about the same as those of the corn-shucking. The term "log-rolling" has been adopted as a political term, meaning: You help me, and I'll help you. New houses were frequently necessary for increasing numbers of negroes. For erecting the frames of these, "house-raisings" were similarly given. Amongst the women, quilting parties were common.

Churches were liberally provided, and both master and

slave attended church with regularity. In the summer, when crops were "laid by," (work of cultivation finished) there would be, before harvest time, protracted and camp meetings, which would be liberally attended from far and near.

Amusements.

The amusements on the plantation were very numerous. In all of these, the negroes always took an interest, and in many participated.

Fox hunting was very popular. Many planters kept fox hounds, some as many as 25 or 30. It was not uncommon for ladies to ride after the hounds, and occasionally a privileged negro would also be allowed to go.

Almost every planter kept one or two pointer or setter dogs and hunted partridges or quail. This was perhaps the most standard sport.

Besides the setters, pointers and fox hounds of fine breed, kept by the planter himself, his sons and the negroes generally kept up a collection of rabbit dogs, coon dogs and possum dogs.

Fishing was common and popular This was done with pole and line by everybody. The men and boys, white and black, went seining, gigging, grabbling, (hunting fish under stones) and muddying.

Horse racing, chicken fighting, wrestling and boxing were all popular and perfectly respectable. These sports were conducted with perfect decorum; and as a rule there was little or no betting. Betting was not unusual, however, and sometimes it would run high.

House parties and picnics with dancing were frequent amongst the young white people, while barbecues, with political speaking or miscellaneous oratory were indulged in by the older people. The negroes fiddled and danced much.

The white boys and negroes hunted rabbits in day time and coons and opossums at night. The life of the planter and his sons was a hardy one and they loved hardy sports.

These amusements—both in doors and out doors—never interfered with the duties or domestic economies of the household or plantation.

From Slave to Freedman.

During the Civil War, the cotton plantations were practically in charge of the planters' wives, assisted by a few old and decrepit men, and boys under 16 years of age, All other white people had gone to the war. It is the marvel of marvels that in this condition, lasting nearly four years, there was never an outbreak nor a symptom of discontent among the slaves. The negro character itself, the very exact and practical knowledge by the planters' wives of the negro character, and the past training of the negro, all contributed to this result. The extent of the trust that was placed in the negro's keeping, and the perfection of its keeping on his part during the war, can never be fully realized or appreciated.

After the war, when the negro became free and was given the ballot, and when new dominating forces began to appear, the negro soon developed a number of characteristics that had been formerly suppressed or were latent. Adventurers came and misled him in politics; and while under the former control and influence he had been tractable and amiable, under the new ones he became turbulent and riotous. Under bad leadership, and with negro votes State and county governments were set up which became more corrupt and debauching than anything that ever existed before under the form of a government. A State militia was organized, composed almost entirely of negroes. White people were forbidden to carry arms by laws which were not observed, the "Ku-Klux Klan," which was a white man's protective league, was formed; and it was probably this organization which saved civilization from utter annihilation in the South from 1867 to 1876.

White Supremacy.

In 1876 the whites, by great energy, and partly by force of arms, obtained control of the State governments, which were still under the control of the negroes and corrupt whites, and thus ended the semi-anarchistic conditions.

From 1880 to 1900, the political, social and industrial conditions in the South were vastly improved. Manufacturing industries in iron, cotton, cotton oil, lumber and other raw materials were established and prospered, but the voting power of the ignorant negroes made them still a disturbing and debasing influence in politics. From 1880 to 1900, practically all the cotton growing States made laws withdrawing the right of suffrage from the illiterate whites and negroes. This seems to be eliminating the last adverse influence exerted by the black man in politics, industrial development and progress.

TYPICAL PLANTER'S HOUSE—"THE BIG HOUSE."

CHAPTER V.

The Preparation of Cotton for the Market, as Modified by the Abolition of Slavery.

After the Civil War, no quick changes came about, other than proclaimed and legislated changes. The end of the conflict made the negroes legally free; but they had none of the habits or feelings of free men, and it took time for them to acquire them. The skilled laborers amongst them were naturally the most intelligent, and were the first to reach the point of obtaining definite compensation for labor.

The wooden cogs and wallowers of the gin running gear used for transmission of power wore rapidly and required frequent renewal. When these renewals were made by labor that cost nothing, cogs and wallowers were better than cast bevel wheels. But when the labor had to be paid for in money, a demand grew at once for cast bevel wheels. On to the larger wheel, sections of castings were bolted, making of it a large bevel wheel, then a cast bevel pinion was put on the horizontal shaft, the heavy teeth meshing properly with each other. The application of cast gearing about a gin house was probably the first move in the direction of saving labor.

Labor Saving Devices.

It soon became difficult on a farm to command or coax enough negroes together to gin a crop of cotton, so demoralized had they grown with their ideas of freedom. To them, freedom was absolution from work, and liberty to overstep all bounds. This difficulty of obtaining labor was accentuated by the advent of a system of separate farming, in which negroes rented lands on their own account, and only worked enough to make themselves a bare

A spirit of interest began to manifest itself amongst planters in the introduction of appliances tending to reduce the number of hands and other annoyances connected with the preparation of cotton for the market.

Wrought band iron rapidly took the place of ropes for binding the bales, both as a matter of economy and for safety from fire. The turbulent times growing out of the entrance of the negro into politics, made important the question of fire risk, which was formerly almost nothing.

A mechanical attachment called the feeder, (A Fig. 21) into which the seed cotton could be put from time to time, and which would, with proper adjustments, feed the gin, was now invented and much purchased. This dispensed with the ginner or his helper. Co-incident with the "feeder" came the "condenser," (G Fig. 21) which was an attachment to the gin to catch the lint cotton between two skeleton wire-cloth-bound rollers, delivering it from the gin in the shape of a continuous "bat", instead of like feathers in a gale. This did away with the lint room hand.

Next came a compact press capable of pressing a bale by the power of two stout laborers This would be located in the lint room, or at some point outside, where the cotton could be conveniently pushed directly into the press from where the condenser delivered it. This dispensed with the hands to carry cotton from the lint room to the screw, and also with the mules and drivers which operated the screw.

During all these changes, the negroes were moving slowly towards citizenship. The number of them owning mules was yearly increasing, and the tendency with the planter was to encourage them to rent land and furnish their own live stock; even though purchased on credit from the planter himself. It was thought that the feeling of ownership would result in better care of the stock. But this rendered more difficult the matter of getting together enough stock to do ginning. Difficulties came also about the matter of keeping up the repairs about the gin house.

When a planter would adopt the tenant system—whether at once, or gradually—then he would disown any responsibility for furnishing facilities to tenants to prepare cotton for market. Co-operative efforts of the tenants to keep up the gin house and screw would fail of good or satisfactory results.

Public Ginnery.

By general consent it was determined that the best arrangement would be for the planter to buy a steam engine, employ an engineer and the necessary force, and gin for the public for a fixed toll. Sometimes this would take the form of a traveling outfit, composed of a portable engine on wheels, a gin set up on a wagon, and a hand press which could be quickly put together on the ground near by. This would go from one plantation to another, stopping sometimes at the old gin house, and sometimes going direct into the cotton fields. See Fig. 18.

These changes may all be said to have forced themselves upon the plantation. They were not the result of any exertion on the part of the planter or the tenant to find better or cheaper methods. Each feature was introduced as a matter of necessity, not as a preferable way, but as an only way the crop could be prepared for market.

The planter thought himself abused, the victim of inferior labor, when he found that he must add to his ginning facilities. But when he established his rights to charge a toll, or other fair compensation for these facilities, and determined to hire and pay for the labor in and about the gin house, then did he begin to realize that he was nearing the end of one of his worst vexations. These industrial changes were not the only ones that were taking place. Agricultural methods were being similarly revolutionized. The plantation tools of 1870 may be said to be the common wood plow stock with a small variety of small iron plow-shares, a common weeding hoe, a scythe, and a wagon. On the same plantation in 1880, one would

be apt to find modern reapers, sulky plows, cotton planters, elaborately made harrows, and like implements. From the close of the war to the present time, the quantity of commercial fertilizers used, has increased from nothing to enormous proportions.

Besides industrial and agricultural changes, a still greater change was in progress, viz: the complete political and social revolution of the entire country. Many a personal conflict between the whites and blacks, reported as a Ku-Klux or political row, was the result of honest differences between employer and employe, upon unsettled business questions, aggravated by political agencies and prejudices. The wonder is, that where such vast changes were transpiring, the friction of the changes caused no more extensive trouble, plenty though there was.

After some experience with steam power, its application to the cotton press, as well as to the gin, became common, and from a source of expense, trouble and worry, ginning quickly became a source of satisfaction and profit. This was effected by steam power, improved facilities, and the ordinary application of the principle of compensation for value received.

The question of ginning began now to receive much intelligent thought. A good steam ginnery came to be as much a standard property as a mill for grinding corn or flour. Whoever could attract the most public custom, gin the cheapest, and give the best satisfaction, as to appearance of lint produced out of the same quality of cotton, could make the most money.

Following these adaptations were well designed modern steam ginneries, well equipped with labor saving devices and appliances.

Fig. 19 shows a brick ginnery with spiked belt elevators for handling seed cotton. This was well equipped with overhead water tank, hose and automatic sprinklers for fire protection.

About 1885 to 1890 exhaust suction fans began to ap-

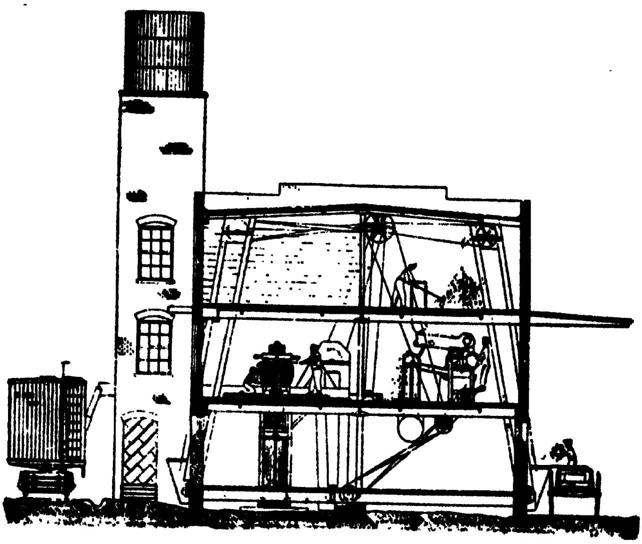


FIG. 19.

Improved Ginnery.

pear, with which seed cotton could be unloaded from the wagon through a pipe or flue and discharged into the gin feeder, or into bins partitioned off in the gin house. Or, if it was desirable, to hold seed cotton in storage, it was often done in small storage rooms, built apart from the gin house proper. When desired, this cotton would be fed to the gins direct from this outer house, or from a wagon, through a flue connected with this exhaust fan. See Figs. 25 and 27. For disposing of the seed as they come from the gin, spiral steel conveyors were brought into use, arranged to discharge the seed through an opening in the bottom of them, or into a customer's wagon outside of the building.

The seed, not needed for replanting, were formerly thrown out and allowed to rot and were then used as a fertilizer. They rapidly came to be sold to the cotton seed oil mills at good prices; others were cut up in suitable mills, to increase their fertilizing values, and thus they have assumed the position of a legitimate marketable product of cotton raising.

The Problem of Baling.

The most perplexing problem now before those engaged in the manufacture of improved machinery for the preparation of cotton for the market is the question of baling it. Immense progress has been made in the construction and improvement of railroad facilities in the South. The very long distances it was formerly necessary to haul cotton to reach a market, no longer exist, and the construction of new lines is daily decreasing those distances. The product of large plantations is no longer hauled in ten bale loads behind 6-mule teams accompanied by a surplus force of negroes to handle the 500 pound bales. The plantations are cut up and divided. The business of the tenants is separate now and distinct, whether on the same plantation or not. Each tenant must market his own few bales in his one- or two-horse wagon. It would be

a matter of importance to many farmers if the bale was of a size and weight that one man could conveniently handle. The owners of public gins feel, also, the need of improvement in the matter of both the press and bale.

The operation of handling the cotton to get it in the press box; the necessity still existing for one or two men (or a complicated steam tramper) to tramp it in order to get a good bale; the size of the bale; the fact that pressing is a periodic, and not a continuous operation, and the inadequate and incomplete covering, are all objectionable from every point of view. Continuous presses, such as are used for hay, have been used, making smaller and very desirable shaped bales, but the commerce of the country may be said to be based on the old form. Cotton is stored, shipped and sold on commission for so much a bale; and to change the size or shape is to confuse business in all these things. One advantage of these small bales is that the press is powerful enough to make them sufficiently compact for export, whereas, ordinary plantation or ginnery bales have to be repressed in very heavy machines (called compresses) at central points and ports.

Other ginnery presses have been devised to make compressed bales. One method is by folding a compressed lap of cotton in layers, and then pressing the bale. Another is by tightly rolling up a compressed lap into a cylindrical bale. Another is by spirally winding under pressure, and compressing cotton into cylindrical bale.. The most modern of these ginnery presses are designed to make bales as compact, and otherwise even more suitable for commerce, than the enormous and cumbrous compress plants heretofore standing and operating between the ginnery and export markets.

CHAPTER. VI.

The Modern Cotton Gin, Press and Ginnery.

The roller gin for separating lint from seed in Sea Island and other black seed cotton, is of very ancient origin. This machine is not well adapted for ginning the upland cotton of the United States.

The Roller Gin.

Fig. 20 shows a cross section of a common form of roller gin.

Cotton is put into hopper A.

It is pushed forward by the reciprocal motion of feeder B, against leather covered roll C.

Shover B presses the cotton against the leather covered roll which draws the fibre under the stationary knife E.

Beater knife D, in conjunction with stationary knife E, beats the seeds free from lint.

Seed fall through grid F.

Lint adheres to leather covered roll and passes around with it until it is cleared by clearer bar G.

There are several improved forms of roller gins, mostly working on the same principle.

The perfection of the roller gin has been brought about principally in England, for use in India and Egypt. Many of these gins have been brought to the United States, for use in the Sea Island cotton regions, and some few are now being introduced for long staple semi-upland cotton in the Mississippi Valley. A limited business is done in building these gins in the United States, but the gin business of the country is in saw gins.

The Saw Gin.

The original principles of the saw gin as patented by Whitney and Holmes remain to the present day the dominant features of the most modern cotton gin.

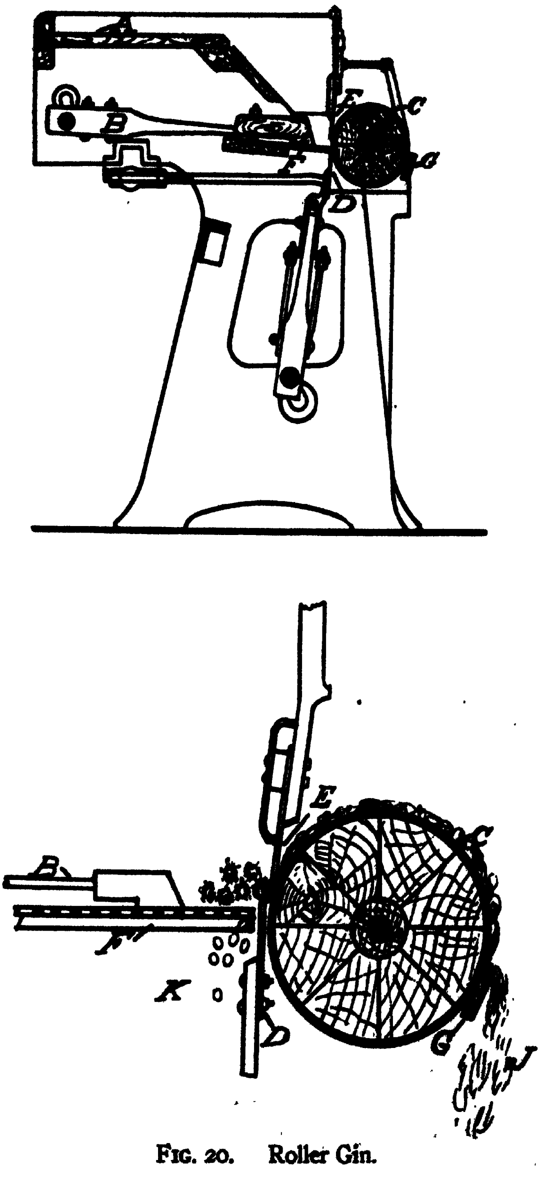


FIG. 20. Roller Gin.

The most important advances in cotton ginning machinery for the past hundred years consist in modes and material of construction; in the manner of applying the driving power, and in accessory appliances for feeding seed cotton to the gin, and taking the products away.

The frame and most of the other parts of the gin were formerly made of wood, while now, the main parts are all of iron or steel. The original conception of the brush remains nearly the same. It formerly consisted of four cross arms, studded with bristles, while now it is a hollow wooden cylinder carrying 25 to 35 rows of bristles.

Fig. 21 is a section showing the principal working parts of the gin of to-day.

Saw Gin, Fig. 21, Lettering.

A—Seed cotton feeder.
B—Revolving distributor.
C—Interior of breast.
D—Saw cylinder.
E—Brush.
F—Flue to condenser.
G—Condenser.

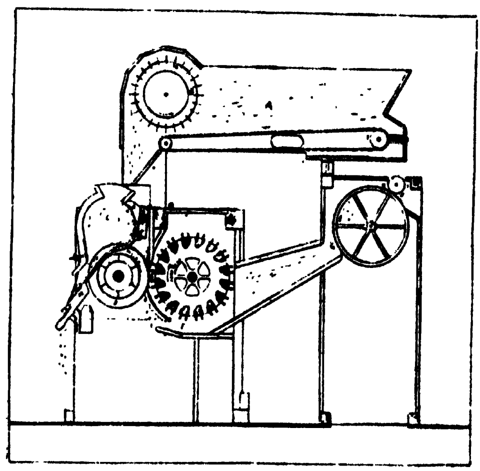


Fig. 21.

Section of Saw Gin.

Process.

The feeder A may be filled with seed cotton. It has means of regulation, and it will feed it with proper speed to the gin. The cotton in the space C is acted on by the saws, which pull off the lint cotton and carry it through the spaces between the ribs M, while the seed, which cannot pass through, fall out in the front. The brush E clears lint cotton from the teeth of the saws and blows it through the flue F against the perforated drum of the condenser. The air passes through the perforations and the lint is delivered on the outside of the condenser in a thick compact sheet.

The pull of the saw teeth on the mass of cotton in the breast, causes it to revolve in the breast in a direction opposite to the saws. This prevents the saws from exerting a too sudden pull on the fibres, and it also serves the purpose of bringing fresh lots of cotton into contact with the teeth. It is important to have the breast so shaped that this cotton may revolve with the least friction. There have been some patents granted on various anti-friction devices, for the breast, such as rollers in the front, and revolving heads at the two ends of the breast. The latter has proven to be of permanent merit

In the gin invented by Whitney it was necessary that the operation of ginning should be intermittent, ginning one breast full at a time, and then letting out the seed. It transpired, however, that when Holmes constructed a gin with saws, the form of breast was improved; it could make and carry a revolving roll of cotton. The breast could be left a little open at the bottom and, when the seeds were sufficiently cleared of lint by the saws, they would drop loose from the roll, having no longer lint enough to keep themselves engaged in the roll.

The Holmes gin works continuously, the seed cotton being fed to it evenly, while the seed drops out as the roll of cotton turns in the breast.

Fig. 22 is a general perspective view of the Holmes saw gin with feeder and condenser.

FIG. 22. Perspective of Saw Gin.

Figs. 21 and 22 exhibit practically the same gin as was used in horse power gin houses shown in Fig. 12, except that feeder and condenser are added.

In Fig. 12 the attendant must remain constantly at the gin to evenly feed the cotton to it.

A gin without a condenser blows the loose, fluffy cotton into a separate room, from which it must be carried out in baskets to the press. The addition of the condenser, as in Figs. 21 and 22, greatly reduces the danger from fire, and enables the machinery to be more compactly arranged.

Huller Gin.

In some sections of the country where the cotton plant grows very large and thick, and ripens fast, the cotton pickers are not careful in picking out the locks of cotton, but mix with the cotton some of the dried bolls, or cells in which it grows. These are locally called "hulls," (though the term is apt to be confused with cotton seed hulls, a product of the oil mill). A special gin has been designed to remove these hulls from the seed cotton, as

the same time that the seed are removed. This is known as a "huller gin".

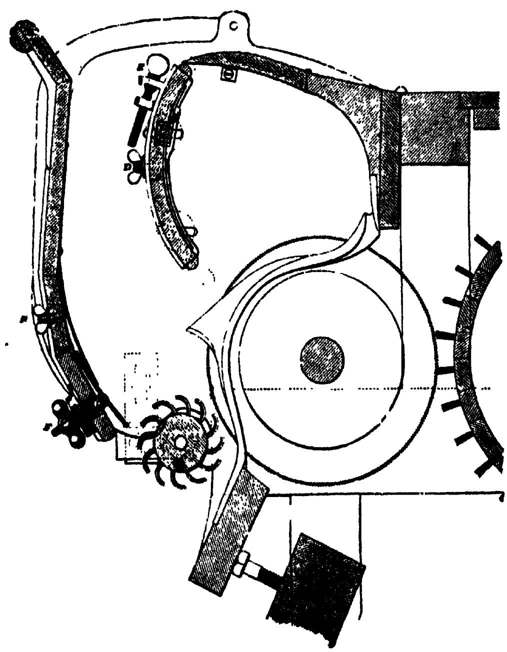


FIG. 23. Huller Gin.

Fig. 23 is a section, showing the general construction of the huller gin. The cotton is fed into an outer breast, at the bottom of which is a revolving spiked roller which combs out the hulls as the saws draw the cotton up into the main or inner breast. From the manner in which the cotton gets into the breast, this gin is also known as an "under-feed gin."

Modifications of Gins.

One maker has made a gin in which the cotton was fed into the end of breast and the roll forced endwise through the breast, the cleaned seed coming out at the other end A linter for oil mills has been made under this same plan.

One maker has made a gin with sectional ribs; that is, with ribs cut in two pieces, the cut being about where the teeth of the saws pass through the ribs and out of the breast box. The size of the gap must, of course, be less than the diameter of a cotton seed.

One maker has made a gin without a brush, using a suction fan to clear the saws.

Numerous other special features have been tried, but none of these various modifications have had any commercial success.

Rating.

All the gins are named and rated by their number of saws. The early gins run by horse power had 45 saws. As the mechanical work on the gins became more perfect, and as steam came to be applied to driving gins, it was found that they could be made to advantage with more saws, so that 60-, 70- and 80-saw gins became common. The most popular size gin at the present time is the 70-saw.

Gins are known as right or left hand, according as the driving pulley is on the right or left hand of the machine when standing in front, where the cotton is fed. Most gins have their brushes driven by a belt from the saw shaft, at the opposite end from the main drive. There is another method, however, in which the entire mechanism is driven with the main belt from a line shaft underneath, as shown in Fig. 24.

Speeds.

The speed of old horse power gins was 200 to 250 revolutions per minute, according as the mules or horses were driven slow or fast. Power gins are speeded faster, even

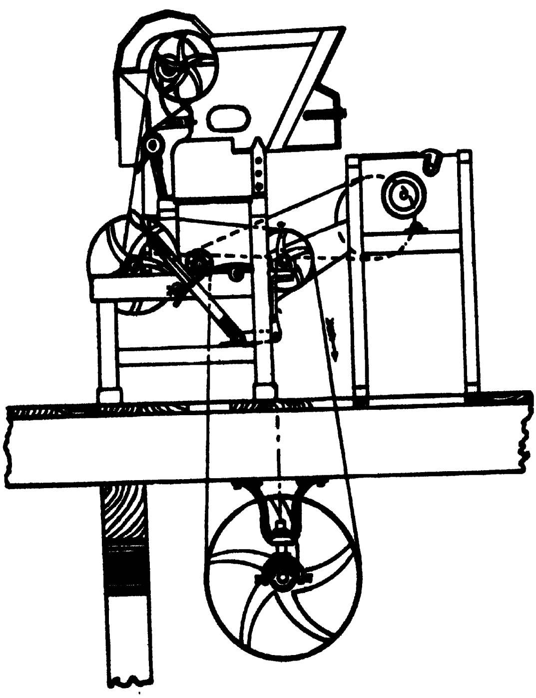


FIG. 24.

Gin Driven from Below.

up to 500 revolutions per minute, for the sake of greater production. The quality of lint cotton produced is greatly impaired by high speed. The action of saw teeth at high speed tends to cut the fibres. The fibres are sometimes cut at low speeds, by improper attention to the gin. If the roll of seed cotton becomes obstructed, and fails to properly revolve in the breast, the roll "breaks": the saws continue to cut through the cotton in the same place and the lint is said to be "gin-cut." A newly sharpened gin will also sometimes cut the fibres. The remedy for this is to fill the breast with seed, close it up, so they will not fall out, put in a quantity of sand and run the gin until the sharp edges have been ground smooth.

Wet cotton often gins badly by gumming the saws and by choking and causing fibres to be cut. Sometimes a small quantity of kerosene oil is poured in the breast with the wet cotton, to prevent the gumming. It is necessary in any case when ginning damp cotton, to occasionally stop the gin and clean off the saws.

Cotton Handling Devices.

One of the most interesting features in the advance of ginning machinery is the means successively adopted for unloading the seed cotton from the wagons of the planters and storing it to wait for the gin, or conveying it directly to the gins.

In the old days, when each planter had his own gin house, with one gin, it was a small matter for his numerous slaves to carry his seed cotton in baskets up to the gin on the second floor. But when the ginnery became a public institution, with many gins, handling ten to fifty bales of lint cotton per day, the subject of getting the seed cotton unloaded from wagons and delivered to the gin, commenced to receive serious attention. Among the first devices used for this purpose, was an endless belt, carrying spikes to pick

up and elevate the cotton in a manner similar to grain elevators, with cups on belt.

Fig. 19 shows a gin house equipped with this style of elevating machinery. This method has now been superseded by pneumatic systems, in which a large suction fan operates on 12 inch galvanized iron pipes, so arranged as

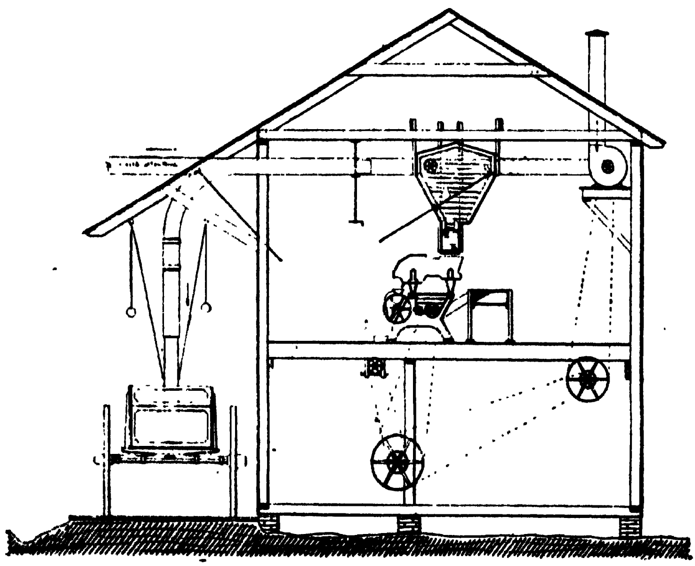


FIG. 25. Improved Ginnery.

to suck the seed cotton directly from the wagons and deliver it to the gins or to storage bins. Figs. 25 and 26 and 27 exhibit some forms of this device.

One of the peculiarities of all the industries relying upon crude cotton as a raw material, is that the entire business for the year must be crowded into the short space of time during which the cotton is being harvested. This peculiarity becomes more marked, as the business approaches

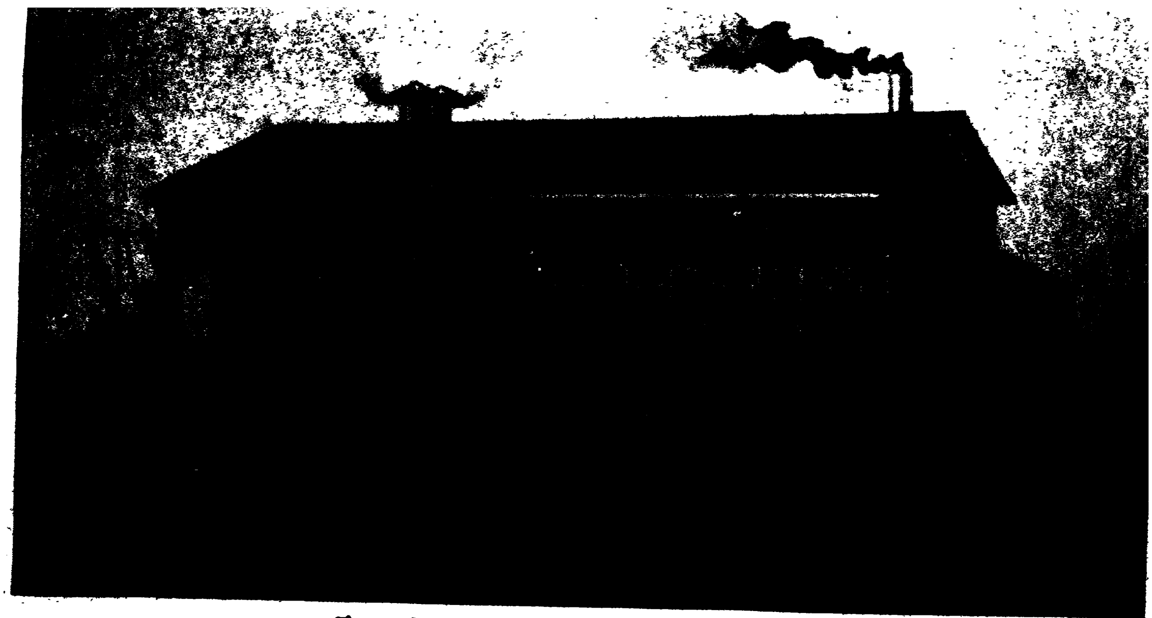


Fig. 26.—Ginnery with Suction Apparatus.

nearer to the cotton plant itself. It reaches the limit in the matter of harvesting or "picking," so that all the labor of picking must necessarily be done as fast as the cotton matures. Ginning is but one degree removed from this; and, while a small amount of storage is possible on the plantation, yet from its great bulk this is unhandy, and the general practice is to have the cotton ginned as fast as picked. Thus it happens that a public ginnery must be equipped to handle large quantities of cotton at a time, during the picking season of three or four months, notwithstanding it must lie idle most of the other months of the year. In order to, in some measure, distribute the heavy press of business on some days, most ginneries have storage bins, capable of holding one to three bales of seed cotton in each bin. (This cotton is of course not in bales, but is usually discussed and measured in terms of the lint cotton it will produce.)

Fig. 27 shows one arrangement of storage bins. The suction fan can take cotton from a wagon and deliver it into any desired bin; or it may take it from any desired bin and deliver it to the gins.

The planter's wagon is usually arranged to hold one bale of seed cotton. He can drive under a suction spout and discharge his load in five to ten minutes. At this rate, about six bales per hour, or 60 to 70 bales per day, may be handled with one suction pipe. The average ginnery in the Southeastern United States has one suction pipe and four to six 70-saw gins, which, when in good order, and running constantly, will gin ten to twelve bales per day each. There are many ginneries in Texas equipped to gin 100 to 200 bales per day. Fig. 28 shows such a ginnery in operation.

The suction fans are arranged to deliver the cotton, and distribute it to the gins in a variety of ways, one of the most common being by means of an endless belt, traveling horizontally in a trough over the feeders By this means several gins may be put to work on one lot of cotton

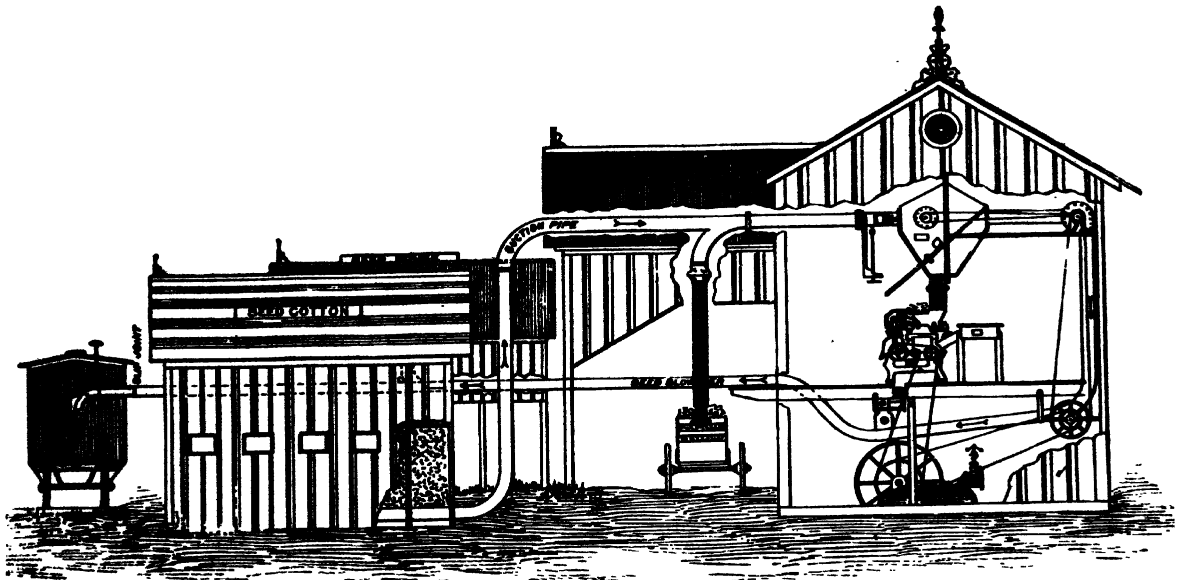


FIG. 27.—Ginnery with Storage Bins.

Fig. 28. Texas Ginnery.

at once, so that the customer usually has but a few minutes to wait for the ginning of his load of cotton.

The seed from the gins are sometimes removed by spiral conveyors, but more often by air blasts or suctions. They are usually deposited in an elevated bin, so the customer may drive under it and receive the seed by gravity. Often the seed are sold to the ginner, who may be the purchasing agent for an oil mill, or who may have an oil mill in connection with his ginnery.

The practice of handling seed by air blast is not to be generally recommended. In the first place, it breaks the seed badly, in turning corners and otherwise. Besides this the blast fills the seed houses with dust and lint.

The system of running a whole battery of gins on the same lot of cotton at once, led to the adoption of a design for delivering the cotton from all the gins into a single condenser, instead of individual condensers, as formerly This effected a saving of labor, and enabled the cotton to be more rapidly delivered to the press. Fig. 26 shows a ginnery with several gins delivering into the same condenser. The air created by the numerous gin brushes, is discharged from the condenser through a large galvanized iron pipe seen extending through the roof.

The condenser delivers its thick bat of cotton directly into the press, into which it is sometimes tramped down by the weight of one or two men. It is more usually, however, tramped by means of a "steam tramper," which is a long steam cylinder, arranged directly over the press, which is, from time to time, made to operate a platen just fitting the press box, thus crowding enough cotton into the box for the principal mechanism to press into a compact bale of about 500 pounds.

Size and Shape of Bale.

The size and shape of the bale has passed through many changes, though varying but little from the average size

of 58 inches long, 30 inches thick and 42 to 46 inches wide. This last dimension is the subject of the greatest variation because this is determined by the amount of cotton put into the press, and by the hardness with which it is packed. Within the last few years, most ginners have united upon a standard for two dimensions, namely, 54 inches long and 24 inches thick.

Designs of Presses.

The mechanism for operating the cotton press has been, and is, of divers kinds. The first press of any general adoption was the large wooden screw, set up outside, and turned by a horse or mule, as variously shown in Figs. 12, 16, 29. Afterwards, the same arrangement was adopted, using an iron screw in place of wood, with the result of greatly reducing the size. At a later date the screw was arranged with clutches and gearing, so that it could be driven by a belt from steam or water power. One of these presses is exhibited in Fig. 30.

Presses are also actuated by hydraulic power. These have a vertical cylinder and plunger, about 10 inches in diameter, and of a length equal to the travel of the press, which is usually about seven feet. The cylinder is under the press box and packs up. A hydraulic pump forces water or oil under the plunger at about 600 pounds pressure per square inch on the plunger. This makes a total pressure on the bale of about 47,000 pounds.

Some presses are actuated by direct steam presssure, as shown in Fig. 31. These have a vertical steam cylinder and piston, about 30 inches in diameter, under the press box. Steam is admitted at boiler pressure of 70 to 100 pounds per square inch. This gives a total pressure on the bale of 50,000 to 70,000 pounds. If the bale is of the standard size, 24x54 inches, this is equal to 40 to 50 pounds per square inch on the bale. This is the amount necessary to make a bale of the average density of 14 pounds per cubic foot, as it leaves the gin house

Fig 29. Old Gin House and Screw.

Nearly all forms of commercial presses may be arranged to pack up or down, to suit the convenience of the gin house. The press shown in Fig. 26 is an up-packing press. It shows one of the latest forms, known as the "revolving box press." This press has two distinct cotton boxes, revolving around a common centre, so that while a bale is being packed, and secured with ties in one box, the large condenser may be delivering its cotton into the other, so that the operation of ginning and packing are very nearly continuous.

Modern Ginnery.

Fig. 26 shows the most advanced design of ginnery now in use in the Southeast for turning out the so-called square bale. To drive the six gins of 70 saws each, with the press and the suction apparatus, requires about 80 horse power, and will gin 60 to 70 bales of cotton per day. It is a model of convenience, but leaves much to be desired from the standpoint of fire risk and from the standpoint of the mill engineer. The building should be of brick, and should be of the standard factory or slow-burning construction. Ther should be some provision for disposing of the great volumes of dust and lint laden air delivered from the suction fans. As it is, this air fills the surrounding country with lint and dust. The fans should be arranged to discharge into a fire-proof dust room of ample capacity to allow it to settle and purify, before emerging from a tall brick flue. There are also other methods of disposing of the dust. It would be better to have all the machines consecutively arranged on one floor, and driven from overhead shafting. The storage bins for seed cotton should be separated by brick walls, and the whole plant should have ample fire protection apparatus. Arranged in this way the insurance rates would not exceed half of one per cent. per annum, whereas they now range from 4 to 8 per cent.

While the various machines entering into the organiza-

tion of a ginnery have been very much improved by invention and design, the old traditions of having one story below to accommodate the running gear or driving appliances, are still preserved. This makes much waste room, and materially increases the fire risk. There would seem to be room for improvement in modifying the forms of some few of the machines, so that there could be an organization of machinery arranged on one floor of a single story building, as is the case with cotton mill machinery. Looking to the accomplishment of the improved organization of the machinery in a ginning plant, it is desirable to have a press that would stand on the floor and have its parts accessible to a man standing on the same floor, and make a bale of sufficient density for export. The handling machinery and condenser should also stand upon the floor in a similar manner.

In the best of the so-called square bale presses, the bales delivered are far from satisfactory. They are not dense enough, the bagging does not entirely cover the cotton, and they are not sufficiently uniform in size and weight.

Compress.

The density of cotton bales is increased by the "compress," which is a very heavy special press, costing about $40,000. It is usually operated in seaport cities and in railroad centres to save space in transportation. These are usually down-packing presses made of heavy iron, and using direct steam pressure. The steam cylinders are 80 to 90 inches in diameter, and they use steam at 100 pounds pressure. This exerts a total pressure of 500,000 to 600,000 pounds, or about 400 pounds per square inch on the bale. This reduces the width of the bale to about 20 inches, and makes it 20x24x54, with a density of about 30 pounds per cubic foot. Fig 32 shows a general view of one form of press. This press has knuckle joints to increase the force of the steam.

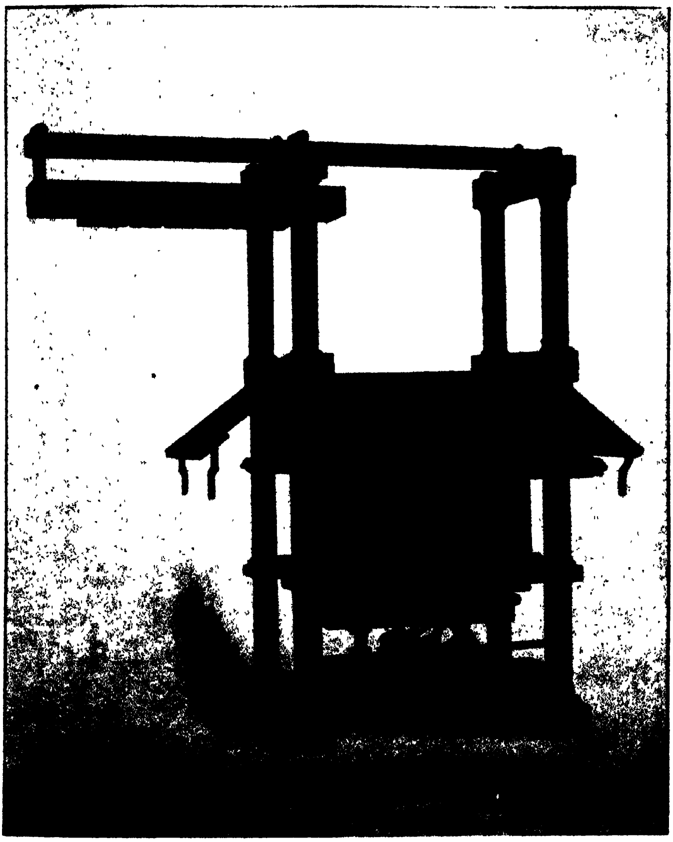


FIG. 30.

Modern Screw Cotton Press.

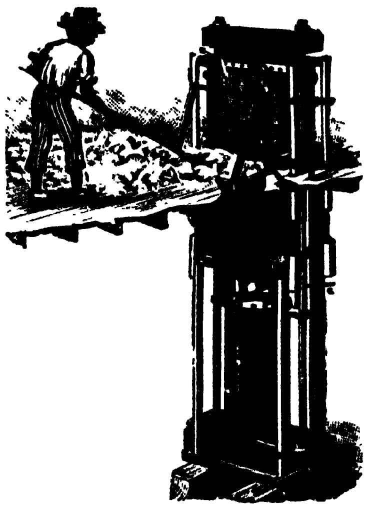


FIG. 31.

Steam Cotton Press.

Ginnery Compress.

Within the past ten years there has been much new work done in trying to produce a bale at the gin house that would have sufficient density for export, and also be completely covered with better material than the coarse jute bagging now in common use.

Ginnery Compress to Make Square Bales, 100 Pounds.

Fig. 33 shows a press that was made the basis of the first effort to revise the shape and weight of the bale, and compress it at the ginnery. This was about 1880. This works somewhat on the order of a common hay press. When this effort was made, neither the commercial nor industrial conditions were favorable to make its introduction practicable. Transportation charges, rents, ginning charges, commercial compensations, commissions and other transactions in cotton were to a very large extent rated per bale—the bale being the old standard 450 to 500 pound plantation bale The proposed press made the new bale about 18 inches square, weighing about 100 pounds, and having a density of about 30 pounds to the cubic foot. This is about the usual density of the old standard bales after being compressed. It was proposed to bind these with wire as a hay bale is bound, and then to slip them into a canvass sack, which could be returned to the ginner by the consumer of the cotton. This press, the new style of the bale and its covering commended itself to all intelligent people who were connected in any way with the cotton industry. But the difficulties of introducing it to supplant the old form bale, with the usages associated with it, were as great as the difficulty would be of introducing the metric system (notwithstanding its superiorities) into an engineering office which contemplated continuing business with the people accustomed only to feet and inches.

In spite of these difficulties, quite a number of these ginnery compresses were introduced. But it could at that

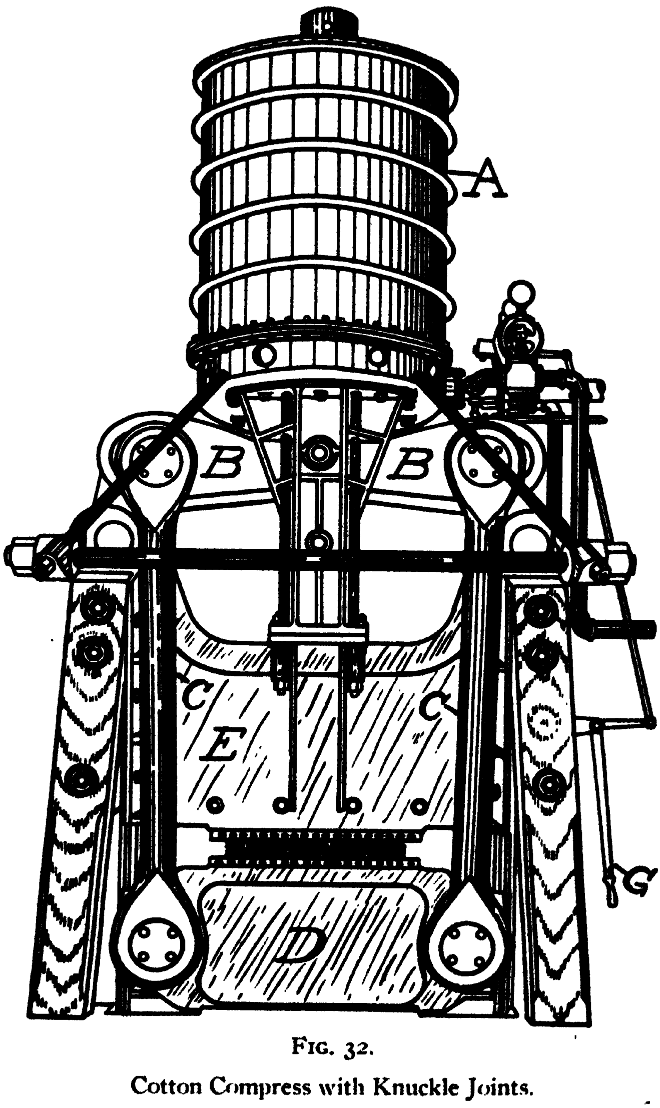


Fig. 32.
Cotton Compress with Knuckle Joints.

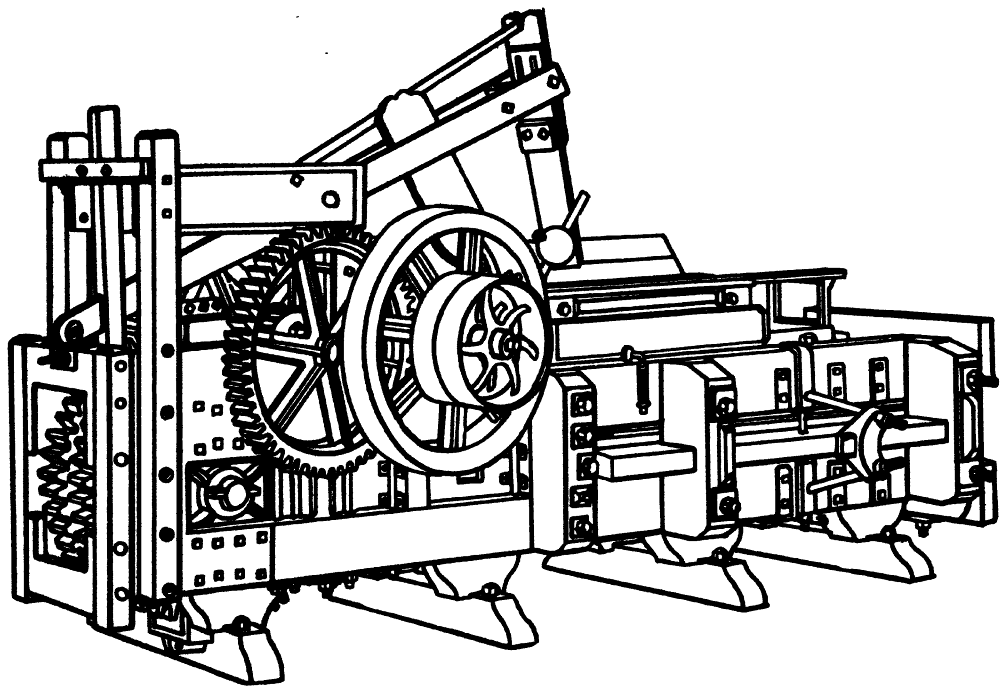


FIG. 33. Ginnery Compress, Square Bale.

time make no headway against the inertia of the old system. About 1895, the controlling force of old influences began to relax, and it began to be appreciated that there was needed a more convenient, more compact and better covered bale than the old style plantation bale. Public interest has stimulated the production of a number of presses designed to produce convenient compressed bales at the ginnery. It is not yet apparent that any of these have surpassed the press shown in Fig. 33.

Ginnery Compress to Make Folded Lap Square Bales. 500 Pounds.

Among the first devices for completing the pressing of cotton at the ginnery, turning out a bale ready for export, was a machine for pressing the sheet of cotton as it emerged from the gin condenser. This machine consisted of two rolls, held tightly together as they revolved, (between which the cotton passed), and a folder which received this compressed sheet, and folded it back and forth in the ordinary cotton press. The rolls performed the real compressing, and the ordinary cotton press merely closed up the layers tight and held them until the ties could be secured. The density of this bale was as great as any regularly compressed bale, 25 to 30 pounds per cubic foot; the bale was of the prevailing shape and size, and all the mechanical features seemed to be favorable to the general introduction of this system. But for some reason this system never reached any commercial importance. The fundamental idea, however, of compressing a sheet of cotton between rolls, previous to baling, is successfully employed in one of the presses now in use for the production of the cylindrical, or so-called round bales.

Ginnery Compress to Make Cylindrical Lap Bales, 250 Pounds.

Fig. 34 shows a cross section of a double continuous press for making cylindrical, or so-called round bales.

Lettering.

A—Flue leading from gins.
B—Wire cloth cylinder.
C—Air vent.
D—Condensing chamber.
EF—Compress rolls.
G—Lap rod.
H—Lap winding pressure roll.
J—Hydraulic pressure cylinder.
K—Wide rubber bale-supporting apron.
L—Tightening roll.
M—Reel for bagging.
N—Valve board.

Process.

Cotton comes from the gins through flue A. The air current from the gin brushes, conveying the cotton, escapes through the wire cloth surface B and passes out the open ends of the cylinder in hood leading to air vent C.

The cotton falls into condensing chamber D.

From condensing chamber it passes as a condensed sheet between the compress rolls EF.

The compressed lap is carried by the bale-supporting apron K to the lap rod G.

It is given a start by hand around the lap rod G.

The lap winding pressure roll H is then set up by the hydraulic cylinder J.

The roll H recedes under pressure as the bale increases in diameter.

As the bale increases it requires more of the apron K

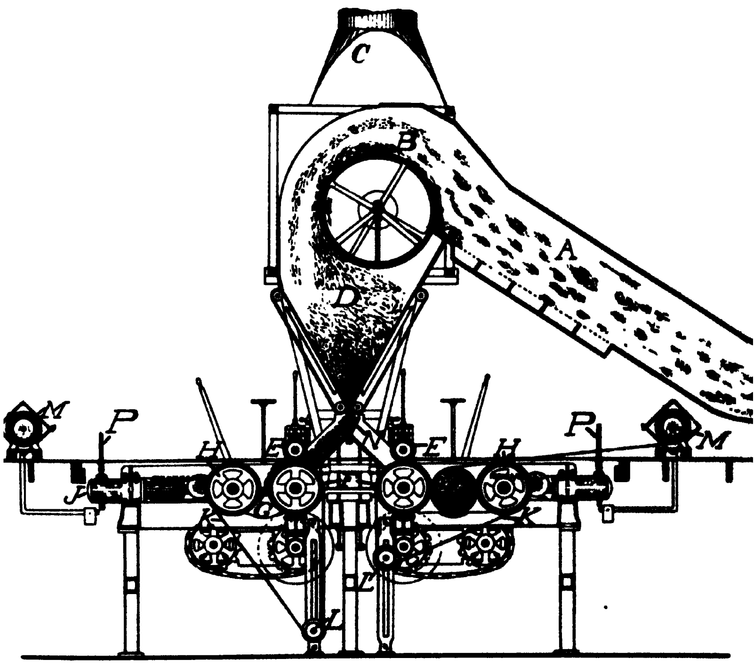


Fig. 34. Ginnery Compress, Cylihdrical Lap Bale.

to support it. This is compensated for by the rising of the tightening roll L.

When bale has become full size, the valve board N is reversed, changing condensed sheet to companion press, which commences at once to make another bale.

Bagging is led from reel M to the completed bale, rolled once around it, cut to length and sewed lengthwise.

Then the bale is taken out, lap rod removed and the bagging closed at the ends.

The bales from this press are generally 40 inches long, to correspond with width of lapper in a cotton mill. They are made to weigh about 250 pounds, have a density of about 30 pounds and are sold by samples, taken while the bale is being made.

The principal objections made to the round lap bale are, (1) that the fibre is injured by the severe pressure put on the lap as it passes through the pressure rolls, (2) that the centre is so tightly wound that it is difficult to open it for use, (3) "false packing," the putting of bad grade cotton in the centre is hard to detect, (4) when used by putting on opener apron and fed direct to picker room machinery as is intended, there is less mixing than is desirable for good cotton mill practice, (5) when piled up in warehouse, the space between bales form objectionable crevices, where fire might occur and be entirely out of reach of fire fighting apparatus; (6) when these bales get wet, the layers tend to become felted and hard, like wood pulp; such layers are useless to the spinner.

Ginnery Compress to Make End Packed Cylindrical Bales, 250 Pounds.

Figs. 35 and 36 show cross sections of another press for making cylindrical bales.

Lettering.

1—Upper part of frame.
2—Friction roller.
3—Frame of revolving baling chamber.
4—Tapered portion of revolving baling chamber.
5—Slatted portion of revolving baling chamber.
6—Head tree to hold slotted plates.
7—Stationary slotted plates.
8—Slots in plates.
9—Pinion to revolve baling chamber.
10—Core to make hole through bale.
11—Hopper for loose cotton.
12—Feeding fingers..
13—Hydraulic ram.
14—Cap for base of bale.
15—Severing knives, attached to baling chamber.
16—Radial slide for knife.
17—Severing knives, separate from baling chamber.
18—Knife rods.
19—Movable bale carrier.
20—Radial arm for bale carrier.

Process.

Cotton is piled into hopper 11.

Fingers 12 force portions of cotton through slots in plate 7.

Cotton in revolving chamber 4 catches the loose cotton and draws it under the plate. The taper in this revolving chamber and the pressure of the hydraulic ram from below, pack the bale.

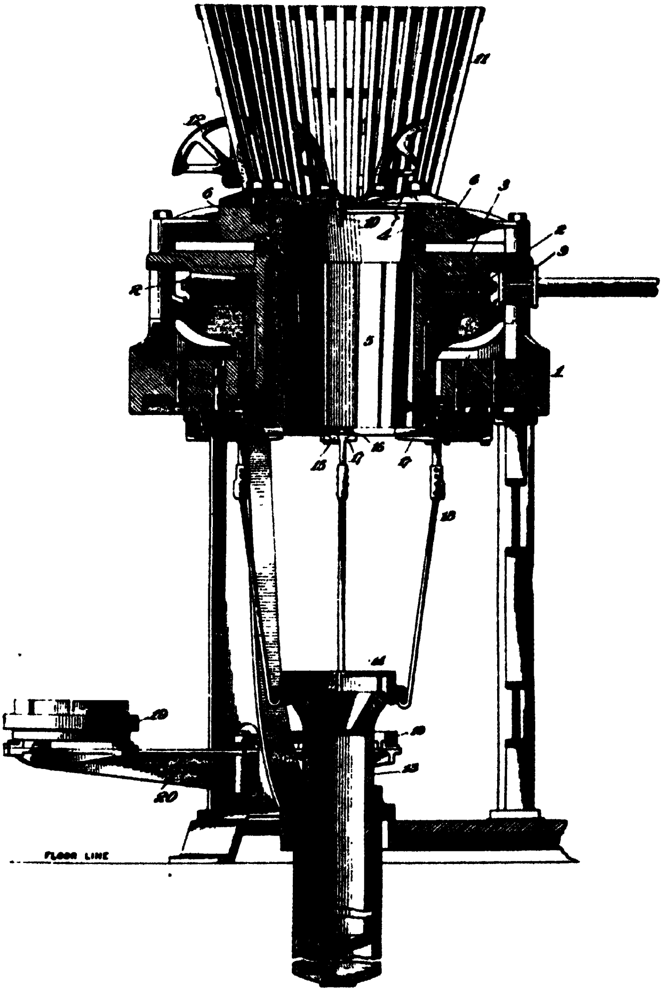


FIG. 35. Ginnery Compress, End Packed Cylindrical Bale.

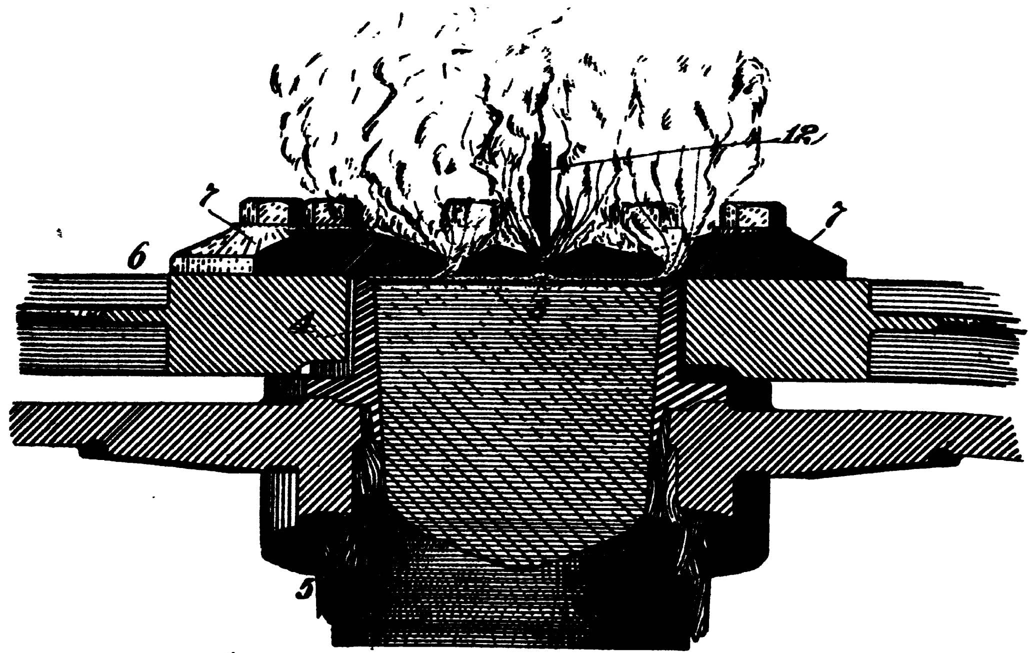


FIG. 36. Ginnery, Compress, End Packed Cylindrical Bale.

As the loose cotton continues to be drawn in, the bale grows, and passes on into the basket section 5.

The bale base on hydraulic ram is forced up against the bale and resists the downward passage with a definite pressure. As bale grows this forces the ram down.

When proper length of bale is made, the bale base 14 engages the knife bar 18 which operates the knives 17 to cut off the bale, while knives 15 support the cotton remaining in the chamber 5.

Ram 13 is lowered out of the way of bale base 14.

Bale base 14 is caught on radial arm 20 and swung out of the way, carrying the bale with it.

The bale is tied with wire and slipped into a sack and tied.

Another bale base is swung into position.

Ram is run up to bottom of baling chamber, the knives are withdrawn, and another bale proceeds from the baling chamber.

This press makes an acceptable bale.

The disadvantages of this press are, (1) the great friction on the cotton as it is drawn through and under the slotted plates has a tendency to burn the cotton, or to discolor it by scorching. (2) There must always remain a certain amount of cotton in the press. This makes it inconvenient in public ginneries, where each customer wants his cotton kept separate, and wants it all, as soon as it is ginned. (3) Same insurance objections as to round lap bale. (4) Additional insurance objection on account of opening length ways (like a "Jack-in-the-box") when wires break, under the action of heat. (5) Hardened edges, on account of friction in taper bale chamber.

Ginnery Compress For Making End Packed Cylindrical Bales, 250 Pounds.

Figs. 37 and 38 show cross sections of still another press for making round bales.

Lettering.

1—Base plate.
2—Supporting columns.
3—Annular top frame.
4—Head tree.
5—Annular rotating ring with bearings to carry compression rolls.
6—Bearings of compression rolls.
7—Neck of compression rolls.
8—Compression rolls.
9—Bevel gear to rotate rolls
10—Stationary rack on which pinion rolls.
11—Anti-friction rollers.
12—Hopper for cotton.
13—Core to make hole in bale
14—Frame for holding interchangeable baling chambers
15-16—Split ring and bars.
17—Hinges.
18—Latch.
19—Base of baling chamber.
20—Hydraulic cylinder.
21—Annular hydraulic ram to carry baling chamber.
22—Inner hydraulic ram, to press the bale.

Process.

Inner hydraulic ram 22 forces base of baling chamber 19 up against rolls 8.

Cotton is put in hopper 12.

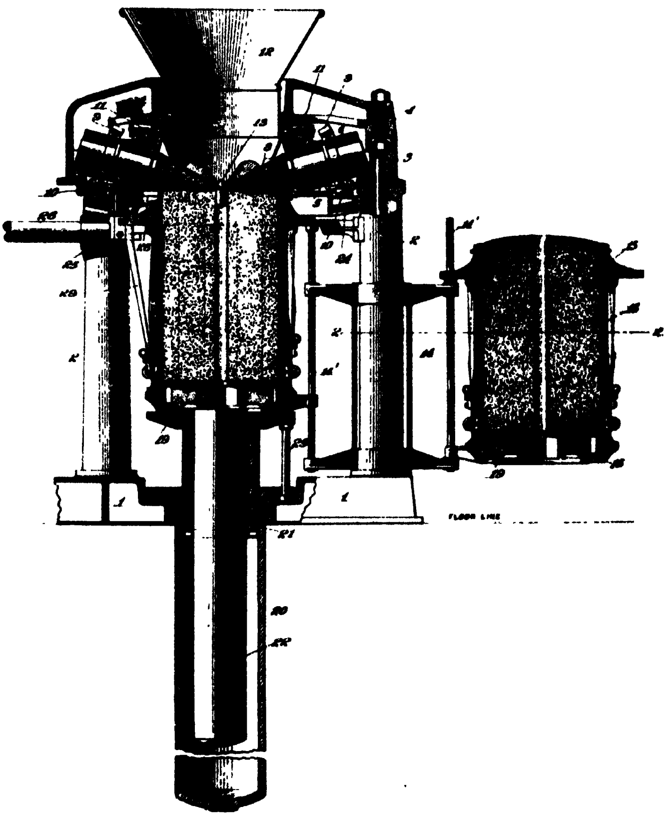


FIG. 37. Ginnery Compress, End Packed Cylindrical Bale.

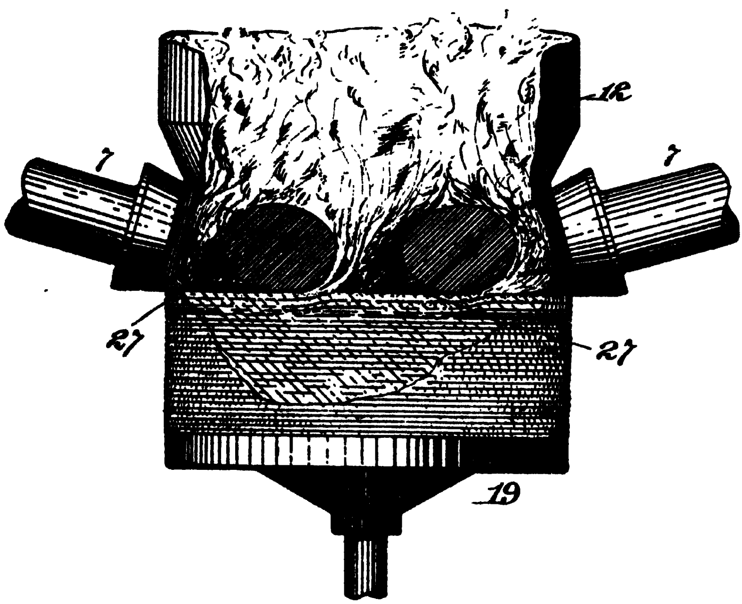


FIG. 38. Ginnery Compress, End Packed Cylindrical Bale.

FIG. 39. Three Kinds of Cotton Bales.

Shaft and pinion 26 and 25 transmit rotary motion to annular ring 5, carrying compression rolls 8.

Compression rolls 8 are carried around by rotating ring 5, and are at the same time rotated on their own axes.

Cotton is drawn under rolls 8 and compressed against base of baling chamber 19, which is held hard by the hydraulic pressure, under the inner ram.

As the bale grows, inner hydraulic ram is pressed lower, until bale is finished.

When bale is finished, rams are lowered out of the way, baling chamber is swung out, bale is tied with wire and put into a sack. Meantime, another baling chamber is swung into the press to receive the next bale.

This is a late design of press for making round bales, which is not yet on the market, and whose advantages and disadvantages have not yet been determined.

Many efforts are now being made to produce a satisfactory press to make, at the ginnery, a bale of sufficient density for export, and at the same time meet the requirements of the domestic market. The accomplishment of such a result would seem very desirable. Several such machines now being introduced seem to give fair promise of success.

CHAPTER VII.

The Planting, Cultivation and Harvesting of Cotton.

The cotton herein discussed is the upland varieties of Gossypium Herbaceum cultivated in the Southern United States.

Varieties.

Without entering into the history of this plant and its numberless varieties, a few of the best kinds will be studied. The method of preparing lands, planting, fertilizing, cultivating and ginning will apply equally well to most of the other varieties of upland cotton. The selection of the particular variety of cotton adapted to any special locality, with its surrounding conditions of climate, weather, soil, labor, etc., cannot be predetermined, in the absence of some precedent in that locality. The best that can be done is to select such varieties as have proven best under similar environments, and to finally develop the particular habit of plant best suited to that locality, by a process of annually selecting seed and cultivating. For example, if the ground is very rich and capable of developing large plants with many bolls, a large variety should be selected at the start, and seed should be selected each successive year from the largest and best fruited stalks, at a period of its growth when its fruit is in the most perfect condition. If the ravages of leaf insects are to be feared, cotton with a low habit and a minimum amount of foliage should be selected and bred. If labor is scarce at any particular season of the year, cotton should be selected which will be ready for the harvest as nearly as possible at other seasons. If labor is abundant and cheap at all seasons of the year, it is, in general, more

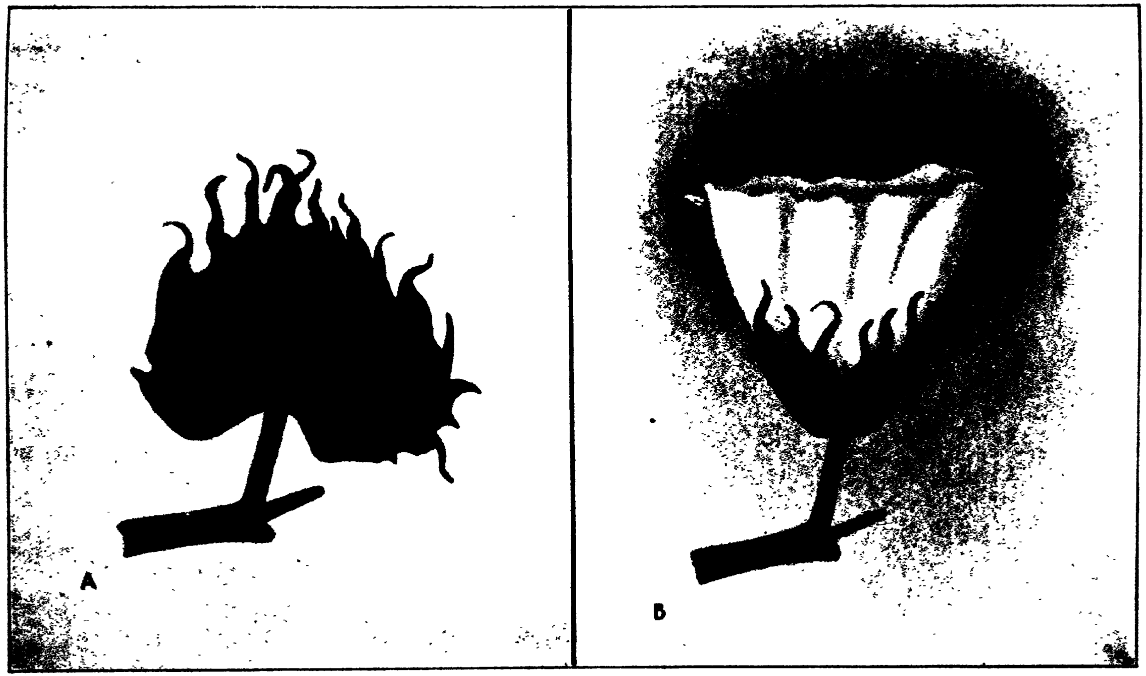


Fig. 40. A, Cotton "Square"; B, Cotton Bloom

profitable to cultivate a variety whose maturity will extend over a prolonged period. This necessitates a larger number of successive pickings, but contributes in the end to a larger yield of the plant. On the other hand, if labor is scarce, a variety must be selected that will require the smallest number of separate pickings, thus enabling the laborer to pick a larger quantity per day. As an example of two extremes in this particular, the variety known as "King" produces 40 per cent. at the first picking and 40 per cent. at the second picking, at dates about two weeks apart. The remaining 20 per cent. has to be gathered in from two to three more pickings. The variety "Texas Oak" appears to give the greatest yield of upland cotton, and it yields 10 per cent at first picking, 40 per cent. at second and 40 per cent. at third.

The method above outlined for gradually breeding the special variety adapted to a certain condition, may be termed artificial selection, which is based on the same laws as natural selection. In addition to this, the method of hybridization has been widely and successfully adopted in the breeding of cotton varieties. This is accomplished by cutting out the stamens from the flower of one plant and artificially fertilizing the pistil of this flower with the pollen dusted from the stamen of a flower from a plant of another variety. The flower thus impregnated produces a boll of cotton, whose seeds partake more or less of the characteristics of both parents. The seeds produce a new hybrid variety. This in turn may be hybridized, so that by proper skill, any given characteristic may be accentuated to any desired extent. These cotton hybrids, like most other hybrids, are liable to great variation, and great care is necessary, for several generations, to produce a new variety which shall remain stable and true to name.

Range of Locality.

All varieties of cotton may be grown through a wide range of latitude, and various conditions of soil and

vicissitudes of weather, without fertilizing, and with the simplest methods of culture. This was abundantly demonstrated in the Southern United States, on the liberation of its slaves. These people were absolutely without education, and totally incapable of thinking or planning for themselves. They naturally continued farming as an occupation, but signally failed in all crops but cotton, which grew in spite of any method or lack of method. But in modern and intelligent cotton farming, the profit arises from carefully considering all the details as to varieties and farming operations.

Habits.

Cotton is planted in early spring, and germinates in three or four days. In about one month it begins to produce buds. The buds are developed in a large involucre which, from its shape, gives to the bud the local name "square." See Fig. 40A. After another month, when the plant is 10 to 15 inches high, this bud opens and produces a white flower about 1½ inches long, and and about the same diameter. See Fig. 40B. The petals turn pink the second morning after its appearance, and drop off the third, leaving the small ovary about ½ inches in diameter, within the involucre. This ovary is known as the "boll," and grows, after about one month, to full maturity, being then ovoid and about 1x1½ inches in diameter. See Fig. 41A. The plant is then mature, and is about 4 feet high. The boll ripens in from one to two months, turning from a bright green to brown, and, becoming dry, cracks open, separating into about five segments. See Fig. 41B. Within each of these segments lightly adheres the lint cotton surrounding the seed, about 32 in number. See Fig. 42. These separate cotton segments are called "locks." Cotton in this condition is generally called "seed cotton," as distinguished from "lint cotton," which is the product

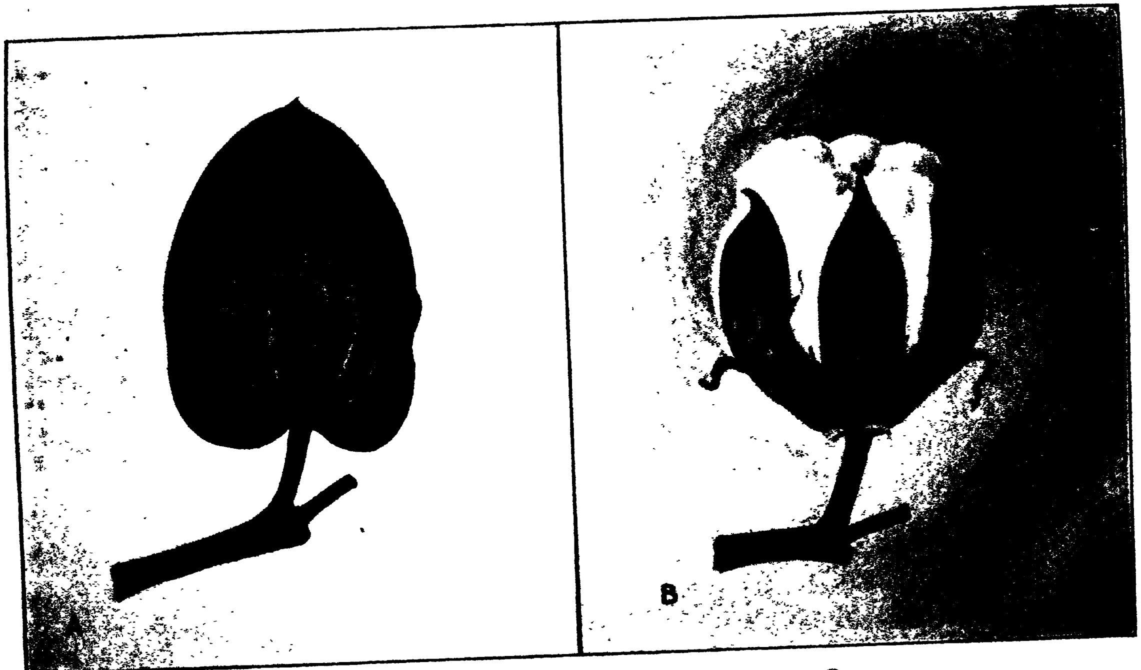


Fig. 41. A, Matured Boll; B, Boll Beginning to Open.

FIG. 42. A, Boll Fully Open; B, Empty Boll.

without the seed, being the article known in commerce as "cotton." There are usually about 10,000 cotton plants per acre.

Yield.

The average yield under moderate cultivation is about 1-10 lbs. of seed cotton per plant, about 1-3 of which is lint, and 2-3 seed. These yields and proportions vary, of course, with variety of cotton and mode of treatment. The long period required for the growth and maturity of cotton, while rendering inconvenient the growth of other crops on the same land in the same year, possesses the great advantages of enabling the plant to average up in its lifetime, extreme variations in heat, cold, moisture and drought; thus a total failure of the cotton crop is practically impossible.

Soil.

Ideal soil for the production of cotton is considered to be fine sandy loam, underlaid with clay; the sand serving to transmit heat and air to the roots, and the clay sub-soil to retain moisture and prevent leaching away of fertilizers. Natural fertility in soil, seems not to be permanent, because, without the annual application of fertilizers, cotton, like all other plants, would, in time, exhaust the land. This time would naturally be longer, the more fertile the soil. But it follows that land which is fertile by nature, is also a land which will conserve artificial fertilizers.

Fertilizers.

While cotton responds most generously to the application of fertilizers, it is not possible to indefinitely increase this yield. The limit of increase depends upon the character of the soil. Though in any soil this limit of increase may be extended by judicious treatment. The reaching of this limit is analogous to the correct propor-

tions of a mechanical structure like a bridge. There must be the proper materials, they must be properly distributed and of the proper weight. In this condition, any increase in the amount of material used actually detracts from the utility of the structure. But it is always possible by readjusting supports, to add new strength by the addition of more material.

The proper method of proportioning and mixing the ingredients to produce the desired results, is fully treated in the chapter on Fertilizers.

Draft on the Soil.

The cotton plant takes less from the soil than most other crops. If the actual elements of nutrition which this plant requires, be annually restored to the soil, cotton may be profitably grown on the same land annually for all time, without any rotation, other than that gained by planting the rows of cotton each year, between the rows of the previous year.

Implements for Cultivation.

Owing to the low mechanical ability in the class of labor that was heretofore almost universal in cotton farming in the United States, advancement toward scientific and complicated agricultural implements has been exceedingly slow. Nothing but the least complicated implements have maintained their supremacy, those which can be easily repaired at the plantation blacksmith shop.

The motive power was the mule; the transmission apparatus was harness with the least number of parts, made of corn husks, cotton ropes and bands and chains (locally known as "gear"); the plow was as simple as could be made, with no adjustments save as to the "point"; the guiding hand was the negro. This was a congenial and a harmonious whole, which the natural law of evolution developed as the most profitable engine—the white man being the

Fig. 43. Negro and Plow.

engineer—for the production of the largest share of the world's cotton crop.

As one after another of social and racial conditions have changed, changes naturally occurred in agricultural implements. As the price of plantation labor materially advanced, labor saving implements naturally came into being, and they were adjusted to suit the conditions.

Figure 43 exhibits the common form of plow, as a whole; the iron part, shown bolted on at the extreme bottom, being known as the "plow point," and the rest of it as the "plow stock." The point of attachment at the extreme right has two divisions; if the draft arrangement is put in the lower division, the plow runs shallower, and if in the upper division, deeper. Formerly the entire plow stock was made of oak, only the point being iron or steel. It is now the universal practice to make them with the iron foot, as shown The handles are 24 inches apart, and the length of beam 44 inches. The weight is about 40 pounds.

Figure 44 shows some of the plow points. No. 3 is the "shovel." It measures 10 inches wide and 12 inches long. It is principally used to run the last or middle furrow in making the "bed." as described in the paragraph on Preparation of Land. No. 4 is the "scooter," or "bull-tongue." It is 4½ inches wide and 12 inches long. It is used to run the first or laying-off furrows in bedding, and to run in many of the subsequent furrows for deepening them. It is also used as a part of a combination shown hereafter. Nos. 5 and 6 are different forms of the sweep. No. 5 is 20 inches wide and 12 inches long. No 6 is 20 inches wide and 12 inches long. The sweep is used in cultivating growing cotton, to kill grass while loosening up the earth to the shallowest possible amount. The sweep is intended to be wide enough from tip to tip to go over in two runs the entire space between two adjacent cotton rows, running as near each row of plants as possible not to actually cut them.

In Figure 45, Nos. 1 and 2 are different forms of the turn plow used for general purposes in breaking up land, and for bedding. No. 1 is 7½ inches wide and 12 inches long. No. 2 is 7 inches wide and 16 inches long. No. 8 is another form of sweep, built up of three parts: two separable "wings," and the centre part, which is the scooter shown at No. 4, Figure 44. The three parts are shown in Figure 46 bolted together with the "heel bolt," which is the bolt used to fasten plow points to the plow stock. This bolt has a thumb nut, which can be screwed up by hand and made tight by striking with a heavy stick or stone, or any object convenient in the field. The width of this is about the same as other sweeps. The centre piece is put on for a guide to steady the plow in its course. It enters the ground far enough away from the plant not to cut the roots, especially when the plant is young. No. 6, Figure 44, runs shallower, and is a better form to use as the plant grows older and the roots reach farther.

Figure 46 shows another sweep built up of two pieces; the same scooter (No. 4, Fig. 44), for a centre, and a flat piece of steel (No. 7) bent around, to form the wings. This is about ⅜ inches thick and 3 inches broad. Built-up sweeps are easier to make and repair than the solid kinds, and they can be made from the ordinary small sizes of bar steel kept around the shop or in stock at the village stores. No. 10 is the hoe used for "chopping out" cotton, or killing the superfluous plants, to leave growing plants at a certain distance apart in the row. The blade is 7 inches wide and 6 inches long. The handle is 64 inches long.

Figure 47 shows two fertilizer distributors; one a tin funnel with long spout, and the other a more advanced form. The funnel is 5 inches wide at the mouth and 42 inches long. It is colloquially known as a "guano horn." A man carries it by means of a rope tied in the two rings, and slung over the shoulder, so that the spout trails in the furrow. He also carries a sack of guano, so placed

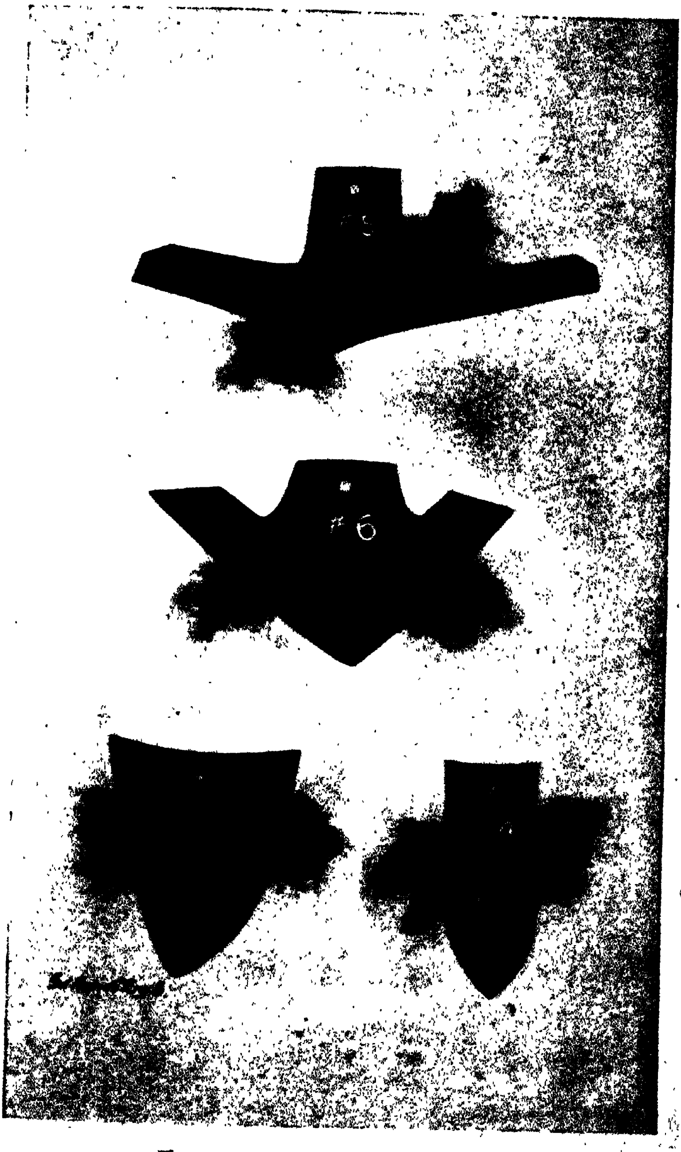


FIG. 44. Sundry Plow Points.

FIG. 45. Sundry Plow Points.

that he can easily take out a cup-full at a time, and throw it in the funnel as uniformly as possible while he walks. The funnel prevents wind from scattering the guano. The machine shown in Figure 47 is pushed by hand so that the wheel follows down the furrow. Guano runs out of the hopper into the shaker, which is agitated by means of cams on side of wheel. The amount distributed may be adjusted by a thumb nut on top, which regulates the distance that shaker hangs from bottom of hopper. The machine is 66 inches long and 24 inches wide between handles, and weighs 40 pounds.

Figure 48 is a cotton planter, which makes a small furrow, drops seed in it at a uniform rate, and covers it. It consists of a hopper, holding about half bushel of seed, supported by two beams which meet in front, and diverge to the handles in the rear. In the extreme front, at left of figure, is a plate with holes in it for attaching the draft arrangement for mule. Directly back of that is a narrow plow arranged to adjust at varying depths to open the seed furrow. Next comes a wooden wheel following in the furrow. A crank is attached to the axis of wheel, which oscillates by means of a connecting rod, a small shaft in hopper. This shaft carries long teeth at right angles to it, to agitate the seed and force them out at the opening in bottom. This agitation is necessary to make the seed fall out, because the particles of adhering lint cause them to stick together and pack. Behind the seed aperture, follows the covering board, attached to the frame of machine by long springs, to compensate for unevenness of ground. The machine is about the same size as the fertilizer distributor and weighs 60 pounds.

Figure 49 is a large sub-soiler, which is but rarely used. Something similar is in use in parts of Texas for originally breaking up prairie lands and putting them in tilth. It is somewhat larger than the ordinary plow, and on account of the heavy "point," weighs 100 pounds. The plow points for use with this plow are cast steel, made

separable, so that parts most quickly worn may be replaced.

Plow points shown in Figures 44 and 45 were formerly made of wrought iron, and had the points plaited or "laid,' by welding on narrow pieces of steel. Bars of iron about 3-8 inches thick and of just the right width for the various plows, were usually bought, along with other plantation supplies, and the plows were forged at home. Now, however, it is the custom to buy plows from the implement factories, where they are shaped out of solid steel by special machines, and are cheaper and better than the home-made article. In any case it is necessary to have a blacksmith forge for sharpening plows on the plantation. It is especially desirable to always keep sweeps as sharp as possible, to the end that they may not fail to cut all grass and weeds between cotton rows.

Preparation of Land.

Land which has never been under cultivation for any crop should be put in readiness for cotton crop in the same general way as for other crops, that is: cleared of all rubbish of whatever nature, and plowed up, to get the land in good "tilth." Except in the case of prairie lands, where heavy grass covers the ground, this preparation should be accomplished as late as possible in the spring, just in time to be ready before planting. Some planters make a practice of preparing cotton lands in the fall for the next spring planting; but it has been abundantly proven that, (except for special reasons hereafter mentioned) such work, on the average cotton land, is worse than useless, for the reason that it softens the land for the reception of winter rains, which leach away much natural plant food. The practice of fall preparation originated in Northern latitudes, where much snow falls, and where deep freezing is facilitated. Both of these matters are of recognized value to the land.

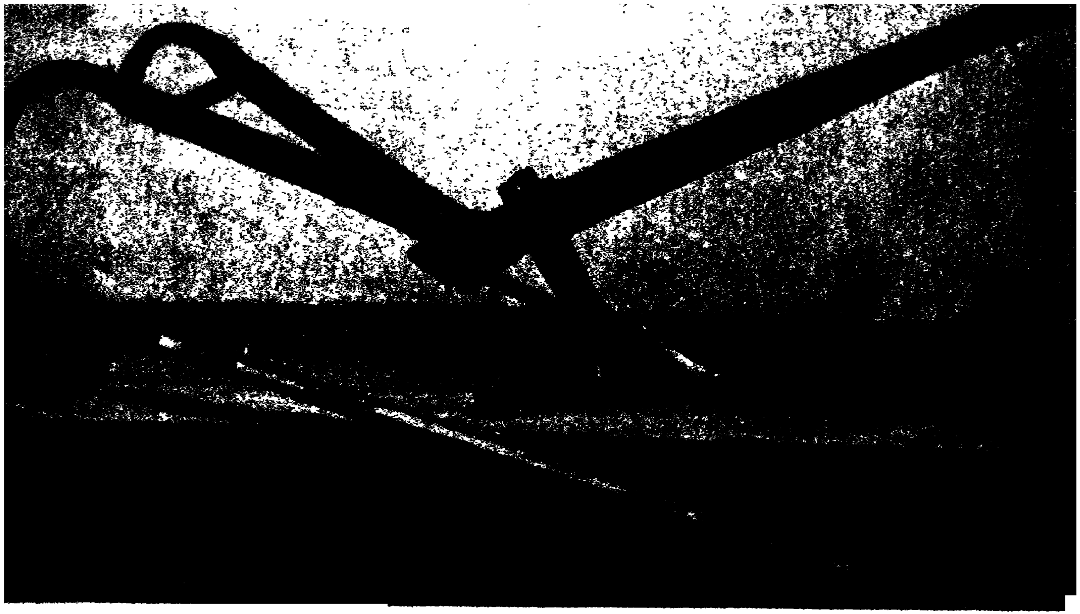


Fig. 46. Plow and Hoe.

All vegetable matter when properly decomposed, is valuable plant food; therefore if the proposed field is covered with dead grass and roots, it should be plowed under in order that it may decompose and furnish food for the new cotton crop. This is a matter requiring careful judgment, in estimating whether the expense involved in turning under the particular grass in question will bring a commensurate return as a fertilizer on that particular land. Its value will always be in its nitrogen; and, if the land happens to be already rich in that element, as in the case of lands in river bottoms and cane brakes, the additional nitrogen is not profitable.

When breaking up land, the plowing must be as deep as possible, and done when the ground is in the right condition as to moisture, so that it will not clod. If, from the nature of the land, clods are inevitable, the harrow must follow. No crop may be successfully raised in soil where lumps and clods exist to an extent to prevent uniformity in planting, covering and cultivating.

When, by the foregoing operations, the ground is brought into good "tilth," the operation of "bedding" is begun.

This is the throwing up of wide elevated ridges, in the centre and top of which, the seed is to be drilled. The width of these beds is therefore determined by the width decided upon for the cotton rows. The entire field is made up into these alternate beds and "middles" or centre furrows. The width of the cotton rows in the Southern States of America is by common consent made four feet, while in the Southwestern prairies, and in the Mississippi bottoms, rows are sometimes six feet. The general rule may be stated that rows are to be laid off a distance equal to the average height attained by the plant.

The first operation in bedding, is plowing a series of furrows throughout the field, at proper distance apart for the rows, (say four feet). On hillsides these rows must run in contours, around the hill, in order to keep as near

level as possible, to prevent washing by heavy rains. Cotton does just as well, if not better, on level ground, and whenever possible, fairly level ground should be chosen. In this case, rows are generally run north and south with an idea to catch the sun more fully between them, and are as straight as they can be plowed. The usual method of laying off rows in the Southeastern States of America is to set up a tall pole (with a piece of cotton or white paper on the top end to make it visible) at the northwestern corner of the field. Start the plow at the southwestern corner; but before proceeding set up another pole four feet east of starting point, for a target for the return row. Plow straight toward the pole at northwestern corner, driving the mule so that the pole is always visible between his ears, and holding the plow steady. At the end of the row (which on level ground may be half a mile long) move the pole eight feet to the east for the next target, and plow south, towards the pole set up at the beginning. An experienced man can lay off rows by this method as straight as if run with a transit. A scooter (4) is the usual plow for this purpose. It does not make a furrow deep enough, but any deep running plow would be difficult to hold in its course with sufficient accuracy for spacing off the rows. Another scooter should follow in the same furrow, and make it altogether at least 12 inches deep. In this deep centre furrow should be distributed the fertilizer, of the amount and kind set forth in the chapter on fertilizers. It should be applied with a fertilizer distributor. See Fig. 47. This machine can be adjusted to evenly deliver any required amount. Other plows follow each other on each side of the centre furrow, throwing the soil toward the centre, until they reach half the distance to the adjacent row. This half-way line is called the "middle." The plows used in bedding are, first, the scooter (4) for laying off and sub-soiling in same furrow; then the turn plow (2) on each side, followed by a scooter for deepening, in same furrow. This is repeated

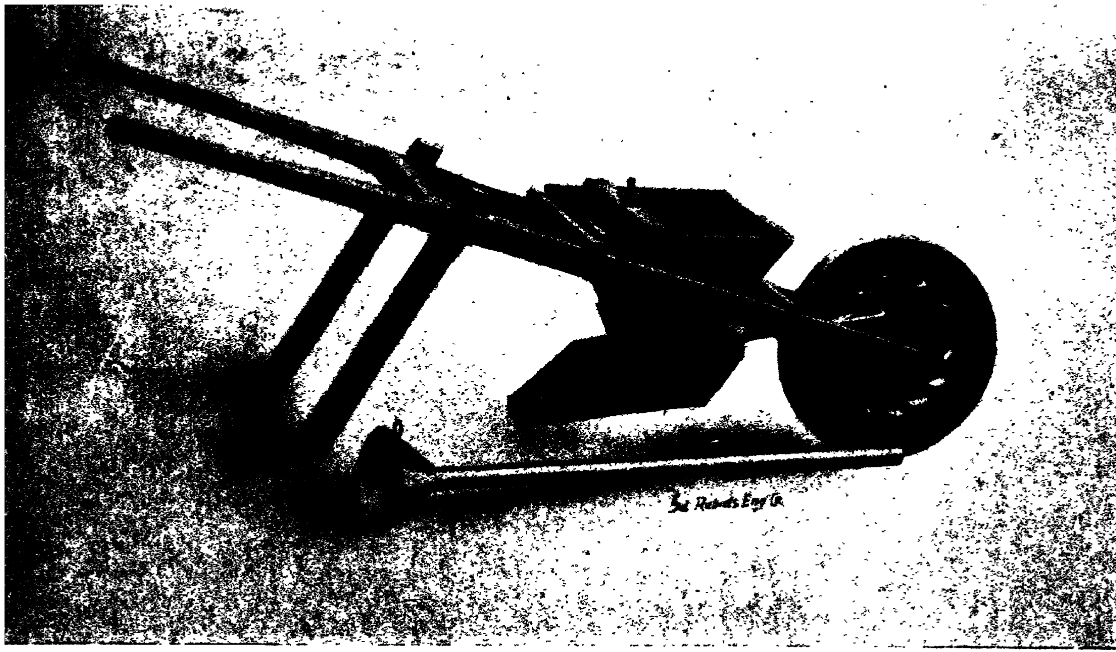


FIG. 47. Fertilizer Distributor and Guano Horn.

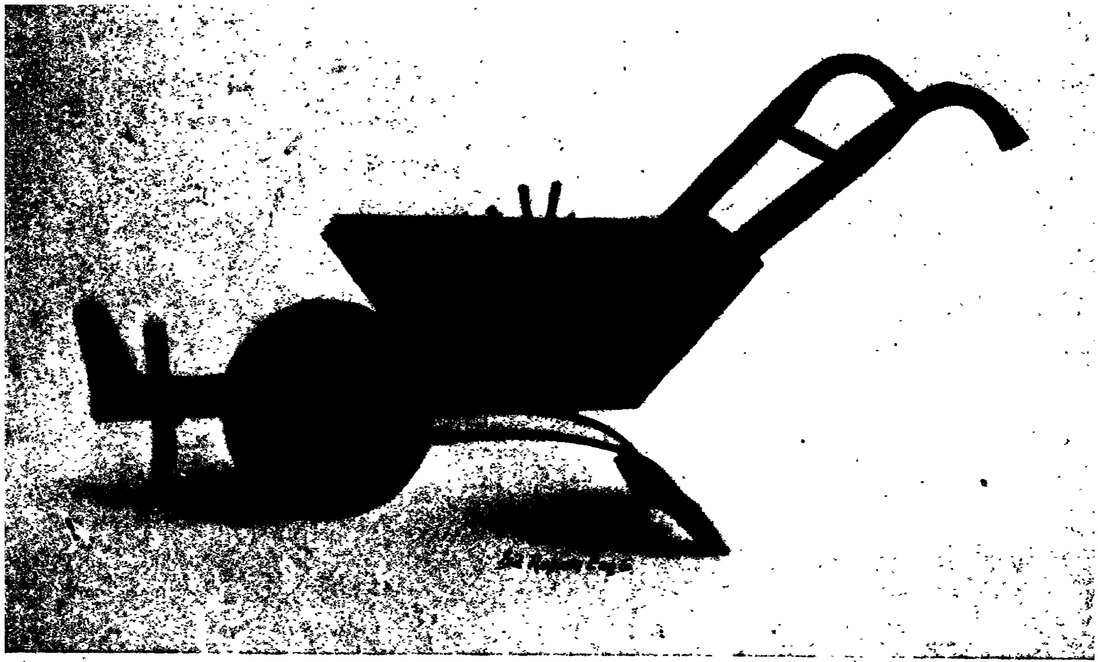


Fig. 48. Cotton Planting Machine.

in furrow after furrow until the "middles" are reached. One line is plowed down the middle with a shovel (3). It requires about 11 furrows to complete the "bed," which forms a ridge four feet wide and rising above the natural level of ground some six inches, flanked on each side by "middles," which appear like flat gullies some six inches below natural level. The ridge itself thus appears to be about 12 inches high. The fertilizer is thus buried in the centre of ridge about 18 inches deep.

One of the cardinal points is to get deep tilth in order to induce cotton roots to grow deep in the ground. Cotton has a tap root, which will, under favorable conditions, go four feet deep in search of food and moisture. The deeper that ground can be stirred in preparation, the deeper the roots will run, thus obtaining a firm hold against storms, and providing the plant with moisture during droughts. It might naturally be inferred that the deep plowing required, could be obtained with fewer furrowings by using a heavy two-horse plow like that shown in Figure 49. There are conditions where this might be true. The soil must be very sandy or friable, so that the large rolls of earth, turned up at each furrow, will naturally fall in a finely divided state. The soil must not be too damp, or the large plow will inevitably leave lumps, while relatively small plows repeated in the same furrow, as described, will reach as deep, and tend to pulverize any kind of soil. If the heavy plow be used, and large clods result while bedding, the evil cannot be remedied with a harrow, as is the case of ordinary breaking up of lands, for the reason that harrowing would destroy the shape of the bed.

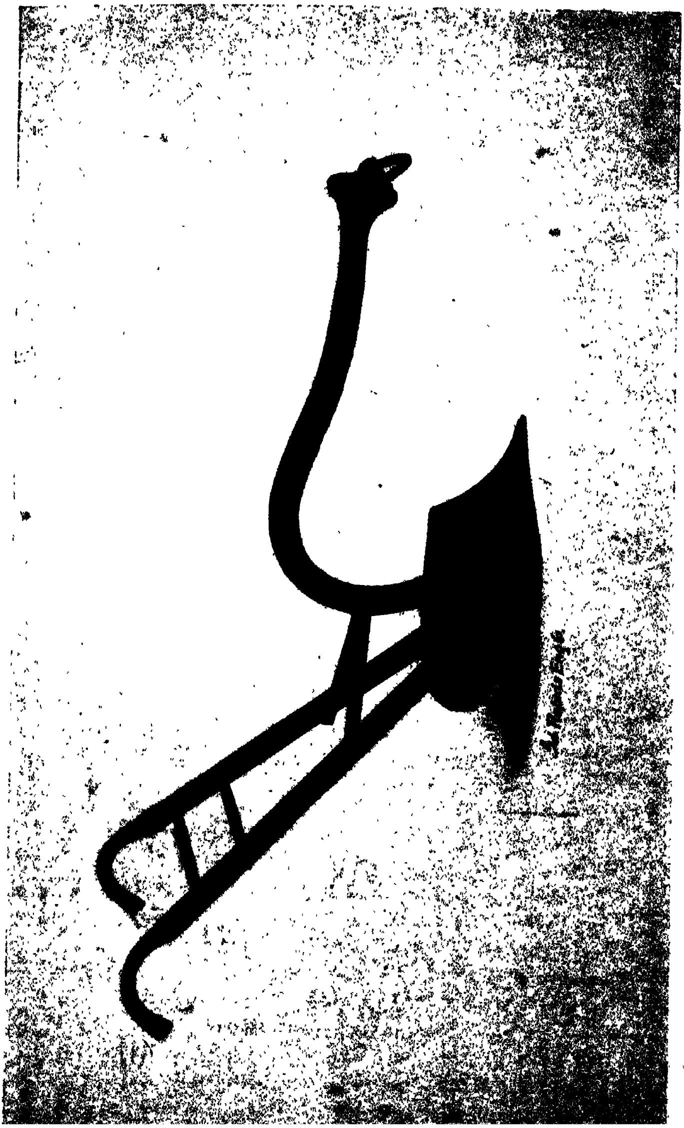
The time required to make beds for cotton, not including any preliminary process of clearing the land and putting it in "tilth," is based on the average distance walked by a mule while drawing a plow, say 17 miles per day. For rows four feet wide 11 furrows per row, there are 22 miles of furrows per acre, hence one plow can bed .8

acres per day. The number of mules and plow hands must be so calculated that all the land designed to be planted in cotton, may be prepared within one month previous to the date of planting. This limit is arbitrary, but is based on the fact that (within practical limits) the shorter time the beds lie exposed to the weather before receiving seed, the less chance there is for leaching away the fertilizers, and for settling and hardening of the soil. At the rate above mentioned, one plow can bed about 20 acres per month. This allowance is about the usual practice, and provides for spare time to devote to small food crops generally considered essential in connection with cotton farming.

If cotton is to be planted in a field which has just produced a crop of cotton, the laying out of rows is simplified, because the old beds serve as markers. The new beds are arranged to lie exactly over the old middles, and vice versa. This allows a given strip of land to rest, and to raise cotton alternate years. This practice has the further advantage of allowing the fertilizer furrow to go deeper, as it is already somewhat lower than the top of the bed.

Planting.

The date of planting cotton varies with the climate and with the seasons, from March 10th in Southern Texas to May 1st in North Carolina. The theory is to plant as early as it can be safely assumed that there is no danger from frost. The young cotton plant is very easily damaged. It will stand considerable frost without being actually killed; but it is inevitably stunted, and frequently to such an extent that other cotton planted two weeks later may thrive and produce much better. Cotton has been known to mature a good crop in the State of Georgia when planted June 1st, although the usual date of planting there is April 10th. This is mentioned to show the possibilities in the case when the weather conditions are just right. But such planting as a rule would only be experi-



mental. Early planting is desirable in order to give the plant time to get a firm hold on the soil, during spring rains, in order to survive the long summer droughts, (about 100 days) usual in cotton growing localities. Late planting is generally productive of inferior lint.

A shallow furrow, some three inches deep, is opened in the middle of the bed, and the seed drilled in and covered one to two inches deep. The earlier that cotton is planted, the more lightly must it be covered, because the ground is colder, and the seed has less warmth to make it germinate. An implement called the "cotton planter" (Figure 48) is used for the complete operation of opening the furrow, sowing the seed and covering. It is drawn by a mule in the same manner as a plow, and can be adjusted to distribute seed as thinly or thickly as desired. One man and mule can plant with this implement six to eight acres per day, and it is done with great regularity. Formerly the planting was done by opening places in the bed with a hoe (10) at more or less regular intervals, and dropping a handful of seed into each place, and covering with the hoe. This work was done by women. A good day's work was one acre per day. Four times as much seed was used as with the latter method. The result, too, was not so good, some seed being planted deeper than others, so that some plants came up later than others.

Although the cotton plants, when mature, never stand less than one foot apart, the intention is to drop with the cotton planter one seed every inch. This is to allow for any irregularity in the working of the implement, and for faulty seed. When the plants come up, they are all thinned to the required distance, as hereafter described. Seed is so cheap that but little effort is made to economize in the amount planted. When costly, selected seed is used, or when, for other reasons the price is high, the amount sowed may be with profit reduced.

At the rate of one seed per inch in rows four feet apart. 131,000 seeds are required per acre.. As there are about

5,000 seed per pound it requires 26 pounds, or nearly a bushel per acre. As the plants are to finally stand only one-twelfth the planted distance, it is obvious that, under the most economical system used at present, eleven-twelfths, or over 90 per cent. of the seed is wasted.

The object in planting cotton in ridges, as described, is primarily to drain it of surplus water. The plant does not require much water at the surface of the ground. Incidently, the elevated bed or ridge. gives the roots freer access to heat and air. The "middles" form a complete drainage system for the field, rendering it impossible for puddles of water to stand in the cotton.

Cultivation.

Within three to six days after planting (depending on weather and on care in planting) the cotton plant appears with two (false) leaves above ground, standing thick in rows. When it attains its third leaf it is three to five inches high, and is two to four weeks old. This is the season for thinning out (called "chopping") to the required distance. This is done with the hoe (10), and the intention is to leave only one stalk in a place. The proper distance for plants to stand in the row has never been definitely fixed, some good planters preferring only 9 inches, while others, equally as successful, contend for twice this distance. It would seem, therefore, under average conditions, that the distance apart, within these limits, makes but little difference in the ultimate yield of cotton. The closer the plants stand, the greater the number that may stand on a given area, but (ordinarily) the less yield per plant. Certain conditions of soil and climate, however, seem to produce better at one distance than another, It is well known, for instance, that thick planting superinduces early maturity, so that, if for reasons of early frost in the autumn, or for fear of some late insect pest, it is desired to hasten the maturity of the crop, thick planting would be preferred. On the whole, it would seem bet-

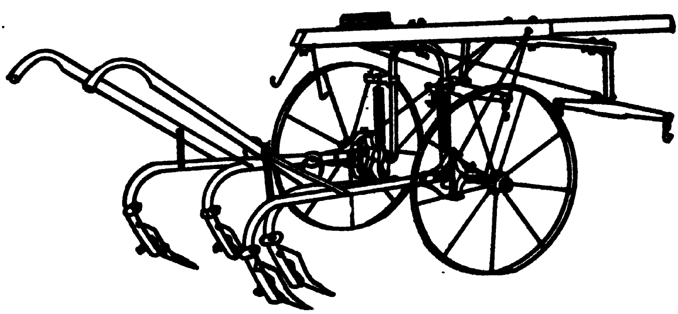


FIG. 50. Gang Plow for Cultivating Cotton.

ter practice to leave the plants not more than 12 inches apart, and trust to high fertilization and cultivation to make each plant produce its maximum. Having determined upon the desired distance, a hoe must be selected whose width shall be equal to that distance, or one-half or one-third of it, so that the chopping may be systematically performed. The average hoe is seven inches wide, and this has been frequently a factor in fixing a distance between plants at 14 inches, so that there would be two chops between the plants.

Experienced choppers perform the work with great accuracy, and do about two acres per day. A matter of the greatest importance in chopping cotton is to have the hoes sharp, in order to cleanly cut the surperfluous plants, and not tear them out of the ground, to the detriment of the remaining plants. Care must be exercised not to cut the ground too deeply and thus disturb the roots of the young and tender plants. This, in fact, is a point to be insisted upon in every stage of cultivation.

Re-Planting.

If, after chopping out, any misfortune befalls the plants, such as late frost, or the ravages of cut worms, so that many scattering plants die, the first thing to suggest itself is re-planting the vacant spaces. This must necessarily be done by hand, that is, with the hoe. Formerly this was much practiced; but it was in the day when all seeds were originally planted by hand. Thus, re-planting in spots would be cheaper than uprooting the entire crop and replanting all at once. At the present time, this latter is almost universally resorted to, owing to the fact that the entire crop can be re-planted with the cotton planting machine cheaper than planting the missing spots by hand; enough cheaper, in fact, to more than pay for the seed and the expense of chopping out again. Procedure on the above basis developed another important point, which has since been applied as a general principle to other crops

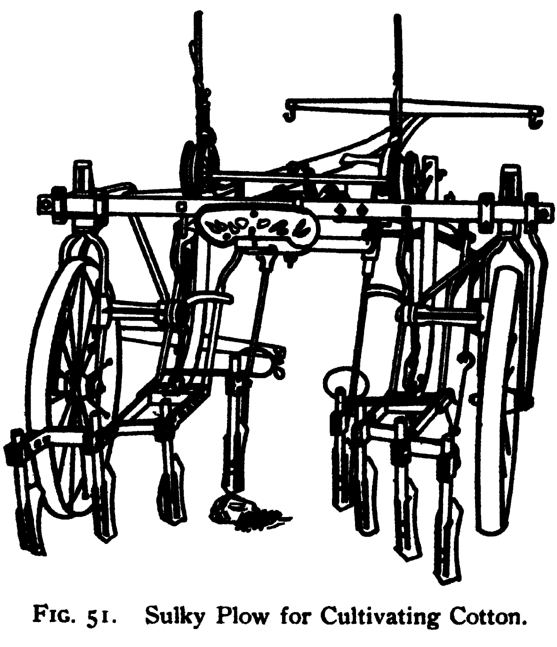


FIG. 51. Sulky Plow for Cultivating Cotton.

as well, namely: re-planting a crop produces plants of different age from the original planting, and hence in all subsequent cultivation, the operation which is correct at any given time for the first planted crop, is too early for the re-planted crop, and vice versa. If proper judgment is exercised, however, in fixing the date of planting, it is extremely rare that any re-planting is necessary. In the matter of frost, it must not be too hastily assumed that the young plant is killed because it lies withered on the ground. It sometimes happens that apparently dead plants will revive after a frost, under the right condition of weather, and grow to perfect maturity.

Plowing.

When the plant is about two or three weeks old, the first plowing for cultivation begins. This is generally done with the sweep (6), which is made in a variety of forms, but all having for the central idea, a broad and exceedingly shallow cut, not exceeding one-half inch. The object of this plow is to cut off grass and weeds growing between the rows, and to break the hard crust on the surface, all without in the slightest degree cutting or disturbing the cotton roots. "Deep preparation and shallow cultivation" must be the planter's motto. This sort of cultivation produces the effect of mulching. It keeps the ground more moist then when left to crust over. The crust consists of numerous capillary tubes which bring up moisture and let it evaporate. Breaking up the crust destroys these capillaries. It has become a homely proverb that "two good plowings equal a rain."

The sweep is so constructed that two furrows with it will about cover the space between the planted rows. Two furrows per row of cotton, then, is the required amount of plowing for this operation, and one man can plow four acres per day.

This same kind of plowing must be repeated about every three weeks, at times when the weather seems fa-

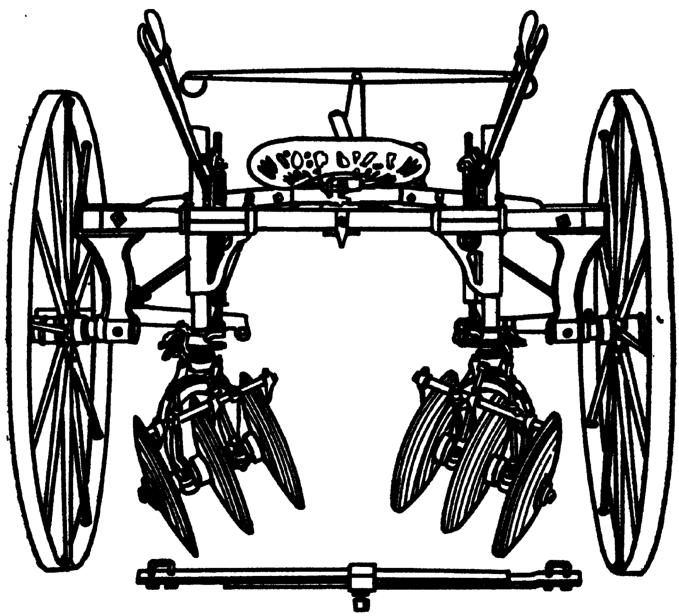


FIG. 52. Disc Cultivator for Cotton.

vorable, that is, not too wet. Dry weather must never interfere. This intermittent plowing is kept up until the plants are well fruited, say August 1st, thus requiring about five plowings, or equal to 1¼ days work for one plow per acre. The number of plows assigned to this work may be so proportioned on a large farm, that they are just able to plow once around in three weeks, so that when they have finished work at one edge of the farm, the first edge is ready for the second plowing. The sweeps sometime leave a small strip in the middles, which may be plowed out occasionally with a shovel (3), if it appears to be necessary. This is colloquially called "bursting out middles."

Hoeing.

It is sometimes, though seldom, considered profitable to hoe cotton, at intervals between plowings. This is to cultivate the spaces between plants in the row, for the same purpose as plowing between the rows. Great care is necessary in hoeing to avoid damaging the limbs of plants. The hoe must not be raised more than 18 inches from the ground, and it must never strike any part of the plant. It is, under average conditions, of doubtful profit When cotton is originally chopped out, any grass or weeds disposed to germinate in the row are supposed to be killed, along with the surplus cotton plants, and the plowing between rows is mostly sufficient to keep the entire crop clean. But, at whatever cost, the field must be kept clear of foreign vegetation. It is self-evident that all the moisture and plant food consumed by foreign vegetation must be drawn from that designed for the planted crop.

"Laying By."

After the last plowing, say one month before the cotton begins to open, the crop is said to be "laid by," and requires no more work of any description until picking time.

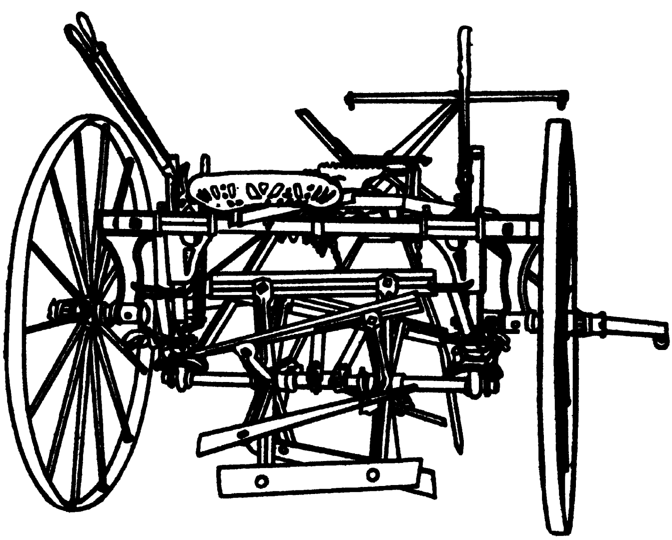


FIG. 53. Cotton Stalk Cutter.

Grass and weeds will grow in the rows to some extent, but as the fruit is already developed, it does not interfere with the crop.

All of the work above outlined to bring cotton to the point of harvesting (not including possible extermination of insect enemies) consists of:

Bedding and fertilizing	11 furrows per row
Planting	1 furrow per row
Chopping out, one hoeing.	
Cultivating (five times)	10 furrows per row
Total plowing	22 furrows per row
Total hoeing, 1.	

When rows are four feet apart, the total equivalent time is one man and one mule two and three-quarter days per acre, one woman (to chop out) one-half day per acre.

Improved Methods.

The foregoing description of the production of a cotton crop is applicable to the most ordinary farming in the sandy soils on the southeastern seaboard. In this region bedding is considered essential, and thus, for the reasons stated, there prevails the laborious system of plowing many furrows with small plows, instead of completing the operation with fewer and deeper plowings.

In many sections of the country, it has been found that except in low-lying fields, where drainage is to be considered, bedding is not necessary, and cotton is planted in drills on the level ground, in the same way as wheat. This method simplifies many of the operations, and conduces to the use of improved implements.

In this case, the largest plows (like Fig. 49), may be used for breaking up ground, and if clods result from such plowing, the harrow may be used to pulverize them, without fear of spoiling the shape of any beds.

The most advanced cotton farmers now use two-horse

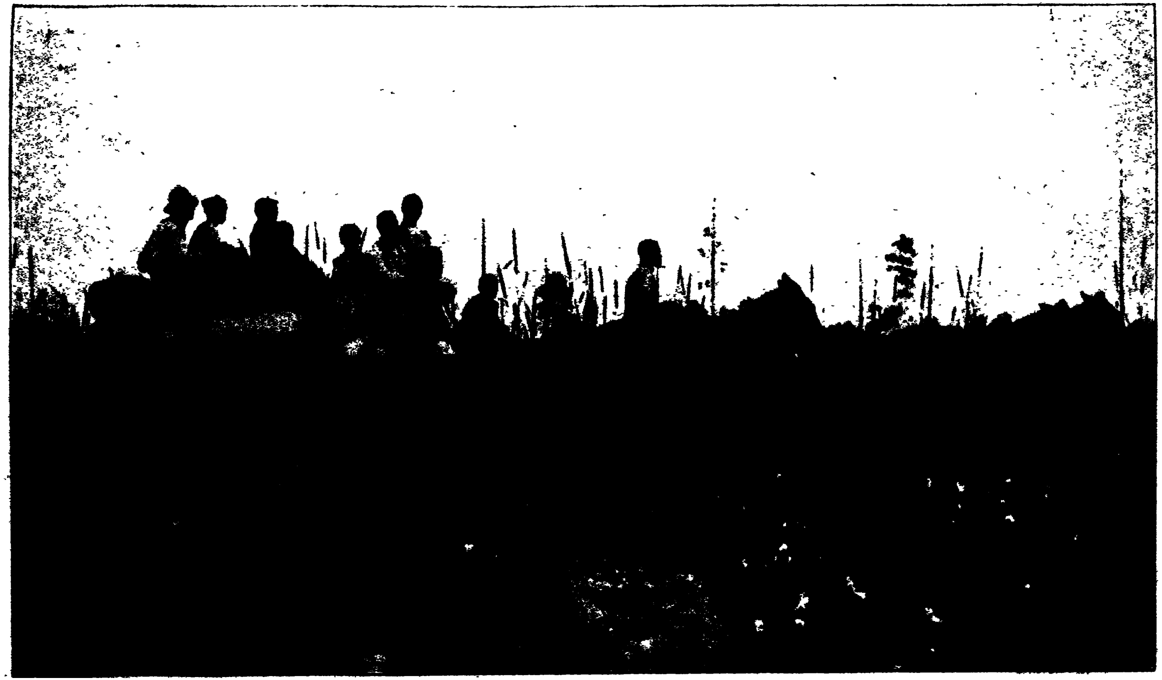


FIG. 54. Cotton Field at the End of the Day.

sulky plows for many purposes. For cultivating between the rows, to keep down weeds and grasses, several kinds of improved implements are in use.

Figure 50 is a gang plow, known as a walking cultivator. A better implement known as a riding cultivator is shown in Fig. 51. Both of these implements have a tendency to plow too deep for cotton, unless intelligently managed. Fig. 52 shows a disc cultivator that very nearly approaches in action the old fashioned sweep. It will shear off the weeds and grass without danger of injury to the shallow cotton roots. The discs are arranged to be set at any desired angle. They may also be used as a harrow. They may be removed and any other kind of plows put in their place. All of these implements are arranged to straddle the cotton rows.

Figure 53 is a stalk cutter. It is very valuable for cutting up the cotton stalks so they may be plowed under. Formerly the stalks were pulled up by the roots and burned, thereby wasting much vegetable matter which should have been returned to the soil. The whole stalks could not be plowed under without making serious obstruction to after-cultivation. But if stalks are cut up fine, they may be plowed under to great advantage. The cotton stalks grown on one average acre weigh over half a ton, and contain about 15 pounds of nitrogen. This is nearly as much nitrogen as is usually supplied to an acre of cotton land in a commercial fertilizer.

Scientific study of agriculture has done much to improve the condition of farms and farmers. Intelligent attention to improved methods and implements is making the production of cotton one of the most attractive of pursuits.

Picking or Harvesting.

The picking or harvesting of cotton is generally commenced in August in the Southwest, and in September in the Southeast. Generally the crop is picked over three times, at intervals of about one month; occasionally the

crop is picked over twice; but sometimes four times; in exceptional cases five times. Men, women and children engage in the picking. Pickers usually carry a sack strapped over their shoulders, into which the cotton is put as picked. The sacks are emptied at end of rows in sheets or in wagons.

In the Southeastern States the cost of picking is from 40 to 60 cents per hundred pounds of seed cotton. In Texas the cost ranges from 60 cents to $1 per hundred pounds.

The quantity one person can pick varies greatly with the person. Children as young as eight years can pick cotton. Those of an average of 12 years can pick 20 to 30 pounds per day. Some adults can pick only 75 pounds per day, while others can pick as much as 300. Most adult pickers can pick from 125 to 150 pounds. Of course, the quantity picked depends to a large extent upon the abundance of open cotton at the time of picking.

The actual work of picking is very light. The bending of the back makes the work arduous. Reckoning one man power as the equivalent of one-eighth horse power, this amount is expended in harvesting about 150 pounds of seed cotton. This is at the rate of 1,200 pounds per horse power per day. It may be estimated that the power as now expended in picking cotton by hand is not more than one-tenth as efficient as the mechanical power which is now in use for ginning. The great quantity of labor required to pick the crop by the present inefficient hand method, limits the quantity of cotton that can be produced per capita. The cheapness of labor for cotton picking is also an important factor. It is related that experiments in cotton culture have been entirely successful in California, but that the high price of labor for picking ($1.50 to $2.50 per day) was prohibitive.

Cotton picking at 75 cents per hundred is a cost of about 2¼ cents per pound of lint cotton. This is one-third of the average market value of the lint.

FIG. 55. Method of Picking Cotton.

In Texas the cost of picking is sometimes one-half the value of the lint cotton. These proportionate costs of picking, viz: One-third in the Southeast, and one-half in the Southwest, represent about the limit that could be profitably paid in the respective sections. The difference in limits is made by the natural fertility of the soil in the Southwest, whereas it is necessary on the soils of the Southeast to apply large quantities of fertilizers.

Referring to the cost of labor in California, ($2.50 per day), it is readily seen that the picking alone would cost 7½ cents per pound of lint cotton.

If a machine could be devised, by which the power of a man could be applied with reasonable efficiency, he could pick ten times as much as by the present inefficient hand method. Assuming the present wages, this would bring down the cost from say 2½ cents a pound to ¼ cent a pound. If such a machine could be adapted to mule or horse power, the cost could be still further reduced, even in connection with higher wages. Such a machine would materially increase the cotton producing area, which is now confined to sections where there is an abundance of cheap labor. The problem is a difficult one. Several machines have been built, but so far, none have been even approximately successful. Several cotton picker schemes have also been made a basis for selling the stock of companies in cities distant from the cotton growing section, when it was well known by the speculative promoters that the machine had no merit.

The difficulties in the way of the invention of a successful cotton picker do not appear greater than those that were in the way of inventing a reaper and binder, or of a sewing machine. The chief difficulty which seems to stand in the way of a successful machine is that it must pick the cotton which is open, without injuring the plant, or any of the unopened bolls.

The production of a successful cotton picking machine would seem to be the most attractive legitimate field now open for inventive talent.

TABLE III.

SHOWING ESTIMATED VALUE OF A SUCCESSFUL COTTON PICKING MACHINE.

Average value of a 10 million bale crop....	$300,000,000
Average cost of hand picking at 66 2-3 cents per 100 pounds..................per bale	10
Whole cost of hand picking 10 million bales..	100,000,000
A machine increasing efficiency tenfold would reduce cost of picking 10 million bales to	10,000,000
Saving by cotton picking machine, 10 million bales (or $9 per bale)..............	90,000,000
Allow for cost of maintenance of machine and mule at $1 per bale; 10 million bales..	10,000,000
Estimated net saving ($8 per bale)	80,000,000

Insect Enemies—The Caterpillar.

The first pest which became familiar to cotton growers of the United States was the caterpillar or cotton worm (Aletia argillacea). It is a slender bluish worm with small black spots, and sometimes with black stripes down its back. Its average length is one and one-half inch. It is the larva of an olive gray moth measuring one to one and a half inches from tip to tip of wing. This moth hibernates in the Southern States in rank wire-grass or other sheltering plants. It comes out in the early spring and lives on whatever blossoms it may find. Only a small per cent. of the moths live through the winter. As soon as cotton plants are one to two inches high they lay eggs on the under side of the leaf, during the night. One moth will lay about 500 eggs. If the weather is warm the eggs will hatch in three to four days, or if cold, they require sometimes more than a week, and sometimes many of the first crop fail altogether. The larva or worm state is

Fig. 56. Experimental Cotton Picking Machine; Rear View

FIG. 57. Experimental Cotton Picking Machine; Front View

from one to three weeks, during which period its capacity for destroying cotton leaves is something incredible. At the end of this stage, it spins a web around itself within a folded leaf, and remains as chrysalis for from 10 to 30 days, when it appears as a moth. It begins to lay eggs when from two to four days old, so that the period of reproduction from the birth of one moth through the successive stages to the next moth is about 50 to 60 days.

The most improved method of combating the caterpillar is to poison them with Paris green. The best way to apply it is to put it into bags of coarse cotton cloth, about four inches diameter, ten inches long. One of these bags is attached so it will lie horizontally, to each end of a pole about five feet long. A man carries this crosswise on the back of a mule, and rides down a cotton row, gently and regularly jarring the pole, dusting out the poison on two adjacent rows at a time. He can poison 15 to 20 acres per day. It is evident that any remedy of whatever nature should be applied during the first generations of the caterpillar, while the weather is least favorable for their propagation, and before their multiplication. A caterpillar of the first generation produces a moth which lays 500 eggs, whose descendents lay 500 eggs each, so that the fifth generation would, without mishap, number over 60 billion descendants from one caterpillar of the first generation.

The Boll-Worm.

Systematic efforts at poisoning, together with the other causes, alluded to, have practically exterminated the cotton caterpillar from the United States, but another pest has grown up which, though not yet very formidable, may in the absence of remedial measures, become quite troublesome. This is the boll-worm (Heliothis armiger). It is in appearance much the same as the leaf caterpillar, but is subject to much variation in color. It is the larva of a moth, similar in general appearance to the moth of the leaf caterpillar, but with a heavier body, and is also subject

to considerable variation in color and markings. Eggs hatch in from two to seven days. If the eggs are laid on the cotton plant, the larva travels over the plant, feeding on leaves until it finds a boll or bud, into either of which it will bore. After a time, it will leave the bud or boll in search of another.

The fact that the boll-worm, unlike the caterpillar, prefers other plants for food, if they are available, renders effective a series of "trap crops." This consists in planting in the cotton field a few rows of corn to mature at different times, and in cutting and destroying this corn at such periods as will catch the successive generations of worms.

Mexican Boll-Weevil.

The only other pest that seems at the present to be of any importance to the cotton plant, is the Mexican cotton boll weevil (Anthronomus grandis). It is a small grayish beetle about one-quarter inch long. This beetle corresponds, in the cycle of propagation, to the moths, previously described. Its larvae, like those of the moths, are the real enemy, but it is generally alluded to as the weevil (and not the worm) because it is most in evidence in the weevil stage, the larvae being mostly hidden in buds and bolls.

The weevil hibernates in rubbish on the surface of the ground. On the first warm days of spring they fly in search of volunteer cotton plants or occasional green sprigs, that in wet seasons come out on the old cotton stalks left standing from last crop. They feed on the green leaves, and when the buds appear, lay eggs in them. Thus, the first generation or two thrive until planted cotton appears, which is at once attacked. As soon as the egg is laid in a bud, and the larva develops, the bud drops on the ground, where the larva finally transforms to chrysalis, and produces another weevil. The total period from weevil to weevil is about 30 days.

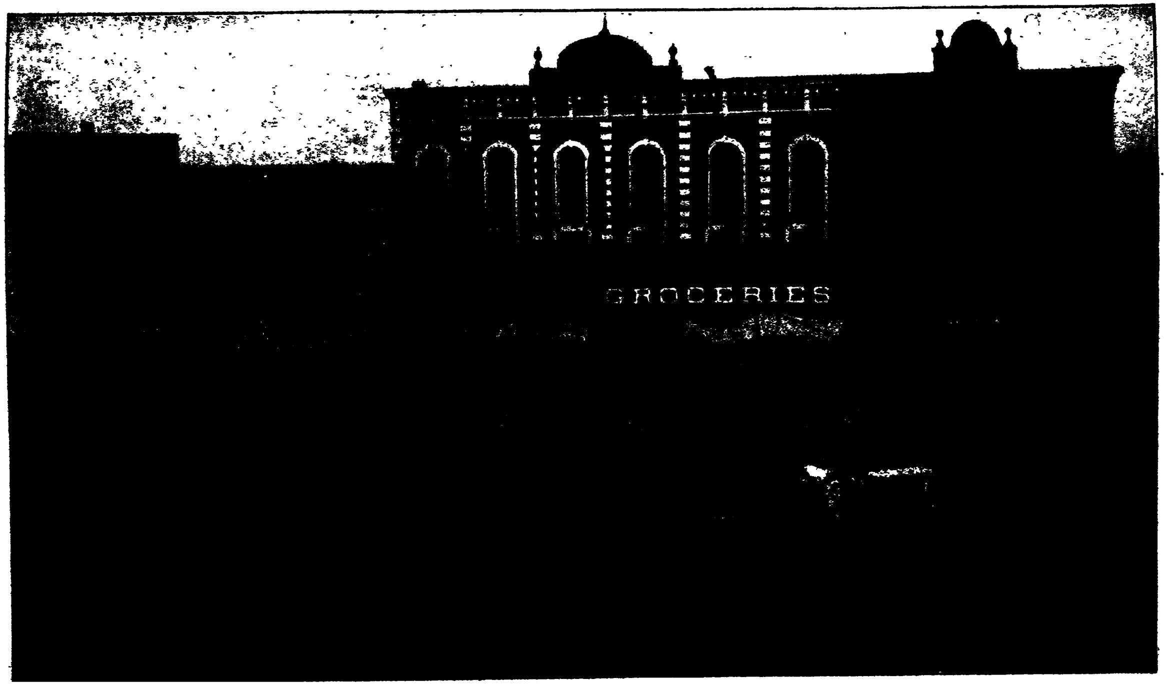


Fig. 58. Cotton Market.

The weevil seems to have been first noticed in 1862 near Monclova, Mexico, and became so numerous there, where cotton was being planted, that the entire venture had to be abandoned. It has appeared in greater or less numbers wherever cotton has been planted in Mexico. Lately, it has found its way into Texas, where it has done considerable damage. It is believed that it cannot thrive in a more northern latitude.

As the larvae do their destructive work entirely within bolls and buds, it is impossible to poison them by any of the usual means, so that the only hope of combating the evil is:

(1) To so arrange the conditions of culture that it becomes difficult for them to hibernate.

(2) To destroy the very earliest weevils as they emerge from winter quarters before they deposit eggs.

The first method is considered the proper one, and the second only as supplementary to the first. The first, or cultural method, consists in so cleaning up the old fields after gathering the crop, that there shall be no rubbish in the vicinity in which the weevils may find a place to hibernate. Old stalks should be thoroughly pulled up by the roots, or if this is impracticable, the stalks should be plowed up, and in either case, piled and burned. This is to be followed by deep plowing throughout the field, in order to turn under and destroy any stray weevils, and at the same time to upturn any chrysalides which may attempt to hibernate in the ground. This method at the same time destroys the insects, and puts the fields in a condition unfavorable to volunteer cotton.

The second method is to poison all volunteer cotton so that the weevil is killed at its first feeding. This may be supplemented by protecting certain small patches of cotton through the winter, and watering it so that it will throw out early green leaves. These leaves are poisoned and all volunteer cotton kept killed down. Poison for this purpose is best applied in a liquid state with a small spraying pump.

Cut Worm.

At present, the least important pest to the cotton plant is the cut worm (Feltia annexa, and others).

Conditions might exist, in which this worm might be important. It is the same worm which attacks cabbages and other vegetables, and the damage done is of the same character, viz: cutting off at night the young plant, at the surface of the ground. Heretofore, it has not been found necessary to take any measures against this worm in the cotton fields, but it is recommended if found necessary, that the same methods be employed as in garden culture, namely: the trap system, in which a crop of some early grass is planted and sprayed broadcast with some strong poison, then cut and thrown in bunches throughout the fields before the young plants appear.

Classification and Spinning Qualities of Cotton.

Most of the elements governing the production of waste in a cotton mill originate with the cotton planter, and increase as they pass on through the hands of the ginner and the buyers. The planter often puts in any kind of seed that he happens to have, and plants early or late, as it suits his convenience. He knows his price is regulated in Liverpool by the average of the American crop, and does not largely depend upon the individual merit of the cotton, so long as it passes the conventional grading of the local cotton buyer. The same reason that retards individual development of improved cotton growing, influences the planter, making him indifferent about the ginning and the subsequent handling.

But the conditions of the cotton market are changing. Liverpool is no longer the sole arbiter. Local mills are consuming so large a proportion of the local cotton, that the price and the conditions of sale are being largely affected by them. This gives a magnificent opportunity for mills in cotton growing territory to make finer discrimi-

nation in the character of the cotton they consume, and make the price of each individual lot of cotton commensurate with the ultimate spinning quality, rather than with the "grades."

In the absence of any good system of testing character and strength of individual cotton fibres, the mill must rely upon practical spinning tests. These soon show, if carefully observed, that the cotton grown by a careful planter gives better results in the matter of waste, and of breaking strength and general appearance of yarn. If a higher price is paid for such cotton, and a lower price paid for others, there will arise an emulation among the planters that will most certainly improve the quality of cotton and of mill products.

There are many facts about cotton that are now well known, but which have been disregarded on account of the market conditions. But these may now reach great prominence if properly stimulated by the mill men. For example, cotton that is planted late, has not time to mature the fibres, and attain uniformity of strength and smoothness and length. Even when it is planted in time the "top crop" is sometimes stunted by early frosts, and the same bad result is produced. Uniformity in length of staple is of prime importance, even more than length in the abstract. A mill with its machinery adjusted for $\frac{7}{8}$ inch staple has better results on fibres uniformly $\frac{7}{8}$ inches long than with some 1 $\frac{1}{4}$ inches long.

Uniformity in length, as well as in other characteristics, is most conserved by uniformity in the variety and maturity of the seed sown, though also influenced by uniformity of soil and culture and fertilization. Careful sorting of the grades, according to maturity and general appearance, while the cotton is being harvested, is of the utmost importance. And finally, the cotton thus carefully grown and assorted should be as carefully ginned. The average public ginnery is equipped for quantity of outturn, rather than quality. This is the logical outgrowth

of the system of grading and pricing American cotton in Liverpool, based on the average crop and conditions. The new conditions, by reason of which the local mills have a voice in the price and grading of cotton, should bring about a reform in the matter of ginning, on the same lines as the reform in raising cotton. Each public ginnery should be equipped with at least one roller gin for handling long staple and other fine grades of cotton. These gins turn out very much less product per day than the standard saw gins, and therefore the ginner is entitled to a higher price for the service. Where ordinary saw ginning of ordinary cotton is worth $1 per bale. it might be easily worth $4 to $5 per bale, to the owner of fine grades of cotton, to have it ginned slowly, on a machine that would in no way injure the quality. This is, of course, based on the assumption that neighboring cotton mills would learn to appreciate the advantages of handling cotton which has been carefully selected, and carefully treated, at every step. This condition of reform must be brought about by the mutual reactions between the planter, the ginner and the cotton spinner. Even in the event that any given cotton mill is not in a position to itself spin these finer grades, it might pay to buy it, nevertheless, and resell to some other mill in order to encourage the planter to produce better cotton. On the other hand, even if the planter does not receive as high a price as he thinks right for his finer cotton, he should encourage the mills to make distinctions, for the sake of finally reaching the point where he can afford to grow the finest grades and demand the highest prices.

The seed for planting should be carefully selected from the plants which produce the best lint. They should not be taken from the first pickings, so early as to make liability to heat, nor from the last picking, where both fibre and seed are stunted by frost or chilly weather. Seed selected at the proper season will produce cotton that will

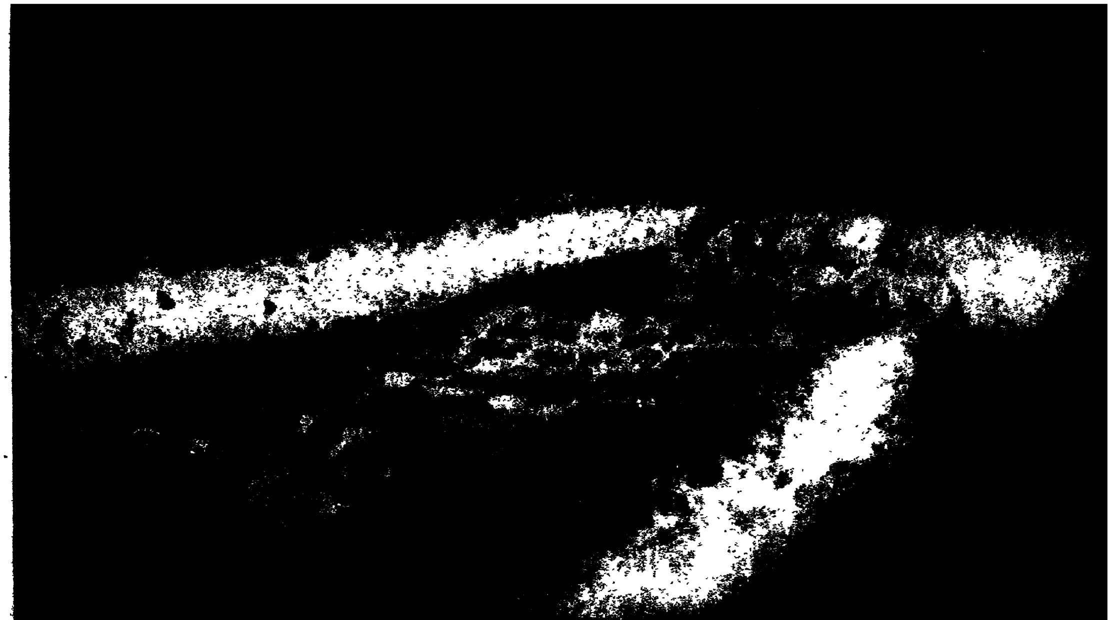


FIG. 59. Cotton Sampler's Table.

spin better, and make less loss, than that grown from seed taken at random.

When cotton is planted late, the crop gins badly. The fibre is easily pulled by the gin saws from the seed and is brittle, and hence such lint is full of broken fibres. Such cotton makes a large loss in the picker room, and the ends break down badly in the spinning room.

CHAPTER VIII.

Marketing Cotton.

When cotton was produced on plantations by means of slave labor, preceding 1860, it was sold in two ways. Those planting on a small scale loaded the cotton in wagons, carried it to the market town, distances of two to fifty miles from the plantation. The market season was in the autumn or winter. In this season, the roads were generally bad; but happily there was at this same season not much other occupation for teams and teamsters, therefore, the time necessary to make these long trips was not a matter of consequence. Arriving in the market town, buyers would approach a wagon, learn who the owner was, and enter into negotiations for its purchase. The beginning of the negotiation was to cut through the bagging covering the cotton, draw out a sample—a good handful, weighing probably a quarter of a pound. The trade might be concluded on the street, or the trade might be concluded in the buyer's office or counting house. The sample became a perquisite of the buyer and was considered by the planter of no consequence. By keeping all these samples in a place provided for them, the buyer would sometimes accumulate several bales of cotton in a season. Generally the planter would negotiate with a number of buyers before closing a trade, and always sold to the highest bidder. This method of marketing the crop was very economical, and always brought the highest price.

The larger planters followed another system. They would contract with a firm of commission merchants to buy their supplies and sell their cotton. Throughout the year, the planter would write to the commission merchant for such supplies as he might need—one or more barrels of sugar, molasses, coffee, rice or such other ar-

ticles as he might need. The commission merchant would simply keep an open account against the planter for all these purchases. He would either arrange with the merchants from whom he purchased them, for credits, or pay with his own capital, or borrow from bankers. The planter's account, based on the cotton he would ship, was considered a good basis of credit. At the end of the season, the planter would send his cotton to the commission merchant, who would sell it, and place the proceeds to the credit of the planter. Some planters would keep good balances with the commission man, and also good balances in the bank; but many of them, after paying the yearly accounts, would spend the balances, and raise a crop the next year on their credit with the commission man. The commission men were, in many cases, men of ample means, but in other cases they were men of scant means, and traded on the credit of the planters they represented. That class of planters who dealt through commission merchants made money easily and spent it freely. They often made trips to New York, and sometimes to Europe, and would make drafts on the commission man with a free hand. It was not infrequent for the commission man to fail, because of too much confidence in the liberal planter's capacity to pay.

During the Civil War the cotton markets were practically closed. Very little cotton was produced. Some little of this was exported in vessels that "ran the blockade." On many plantations, small lots of cotton were stored, and some was supplied to the Confederate government. When the war ended, those who happened to have a little cotton on hand, found the cash proceeds an immense help in getting a new start in putting in new crops. The victorious Federal Government confiscated much of the cotton that was found immediately after the war. To avoid this, the cotton that was held when the war ended was hauled out into the forests, and hid until an opportunity could be found to sell it. Thus exposed to the

weather, it was in many cases much damaged before sold; but cotton was high in price, and it would readily sell in spite of the damage.

After the abolition of slavery and the end of the war, many of the old commission firms were reorganized, and many new ones were formed. Cotton was high, and was again an attractive, but precarious basis of credit. Planters devised systems of working negroes for shares of the crop they made. The freedmen had, of course, no money for his living; the commission man, in turn, advanced these supplies to the planter, under a contract to have a fixed number of bales of cotton shipped to be sold by the commission man at $1.50 a bale commission, besides interest at 10 to 30 per cent. on the money value of the supplies delivered. Thus, for the supplies advanced, the commission man received three different compensations: (1) The commission on the cotton to be sold; (2) 10 to 30 per cent. interest; (3) a profit on the supplies shipped, which ranged from 10 to 40 per cent., besides making a charge for insurance, storage and other expenses.

The commission man, in turn, borrowed money from the banks or Northern merchants, with which to do this business. Some of these commission men, or factors, who were careful and exacting, became wealthy, but many of them failed. The risks were very great, because of the disturbed and disorderly political conditions. Many negroes would start to grow a crop, and never finish it. The advances made to these would be a total loss. In this way many planters would be unable to pay their debts, and the commission man or factor, would, in turn, lose what he had advanced to the planter.

A lien law was passed, by which a planter or merchant at the beginning of a season, could take a mortgage on a crop not yet made, in order to secure advances. Even with liens in force, the tenant or renter would often smuggle one or more bales of cotton to market, and get away with the proceeds. This system of liens, advances and

sales through commission men has been gradually diminishing. Merchants failed, planters failed and tenants got such poor results that the whole system grew unpopular and unsatisfactory. Large plantations began to be cut up into farms and sold, and this process is now going on.

Railways have been extensively built, and now most farms are within a reasonable distance of a railway station where there is a market. There is accumulated capital now, and the local merchant can extend reasonable credit to the neighboring farmer, white or black, and these can sell their own cotton and cotton seed for cash, and pay their bills to the merchant in cash. The large commission house or factor is now gone. The large plantation is practically passing. It survives now in its original state only among the bottom lands of the Mississippi River, Red River and Ouachita River, where the coarsest and most ignorant type of negroes seem to have gathered, and continue to gather. In these fertile, but unhealthy bottoms, large plantations may yet be held together and profitably operated, for some time to come.

Texas is being rapidly settled by thrifty white immigrants on small farms. Some of these farmers come from the East and some from the Northwest, while many are Germans and Swedes, who come direct from Europe. The river bottom planters still do business with surviving commission houses and factors in New Orleans. The Texas farmer usually sells his cotton for cash in the nearby market town.

The modern farmer, white or black, usually carries his cotton to market, one or two bales at a time, in a one or two horse wagon. Sometimes he will carry about 1,000 pounds cotton seed and one bale of cotton in the same wagon. The seeds have now as ready sale for cash as cotton.

Many farmers now ask for no credit or advances. Followed up on modern lines, the cotton farm is a profitable property, and many farmers are not only without need

for advances, but are making and accumulating money. Twelve years ago, the prospects for the cotton farmer seemed gloomy; this is now entirely changed, and the thrifty farmer, near a manufacturing centre, has good credits, and makes good money.

Those who still own large tracts of land, finding it unprofitable under the tenant or share systems of working, and observing that neighboring farmers doing their own work with some hired help are prosperous, are perfectly willing to cut up the large tracts into farms, and sell them to good farmers on long credits.

CHAPTER IX.

The Plantation During and After the Civil War.

. It has been shown on about what basis of profit the plantation could be operated with slave labor.

Paralyzing Influence of the War.

During the Civil War, the cause of which was primarily the differences between the free States and slave States about the institution of slavery, there was practically no cotton raised, except for domestic use and the use of the Confederate government. The able bodied white people went to the war, and the energies of the negroes were applied to the production of food stuffs, clothing and other supplies for the armies. All export and import trade between the cotton growing States and the rest of the world was stopped by means of blockade by the navy of the free States. While the war was begun for the preservation of the union of States, it soon transpired that as strong a motive, if not stronger, among the free States, was the abolition of slavery. The conflict became one of gigantic proportions, the enlisted forces on the one side aggregating about 2,600,000, and those of the other about 600,000. Having given practically all its attention to the development of agriculture, in the period immediately preceding the war, the Southern States, when shut off from commerce by blockade, found themselves not only without many manufactured articles, but also without many of what are usually considered the necessities of life. There was no adequate supply of sugar, no coffee, no adequate supply of salt, no tea, no materials for ladies' dresses, except homespuns. In slavery times, meat was cured by packing it in salt a few days, and then hanging it overhead in a smoke house. In being smoked it would dry,

and the salt would fall off. During the war, many a plantation got its salt supply by digging the earth out of the smoke house, putting it in a hopper, pouring through water to leach it out and then boiling out the water to get the residual salt. Parched corn, sassafras, sage, parched oats and other substitutes for tea and coffee were tried and much used. Home made molasses, in place of sugar, became general, and homespun clothes for fine ladies, the fashion. In all privations, the negroes cheerfully and loyally participated, and there was never a murmur of discontent. At home, on the plantation, the planter always stood for the defence of his negroes. In war he assumed again to do all the fighting for himself and his. The negroes were never called upon to strike a single blow in the war on the Southern side, and their loyalty to the man who was doing the fighting was perfection itself. Subsequent events exhibited that this was a loyalty that was not innate in the negro character, but had been developed by the preceding conditions and events.

As a result of the war, slavery was abolished, and the seceding Southern States returned into the Union. The Confederate States ceased to be, and the United States, now all free States, became again a single nation, made up of all the States.

Negro Suffrage.

Besides bringing the seceding States back into the Union and abolishing slavery, the victors in the conflict also determined to give the right of ballot to the freedmen. In a number of the States, these freedmen were in the majority. Besides the great political problem thus created, it was necessary also to take up and formulate some system of labor. The war had practically swept away all property, in the slave States, except land, and that was much depreciated by the destruction of the labor system and the want of working capital. Cotton was high in price, because of scarcity—for four years none had been supplied to the markets.

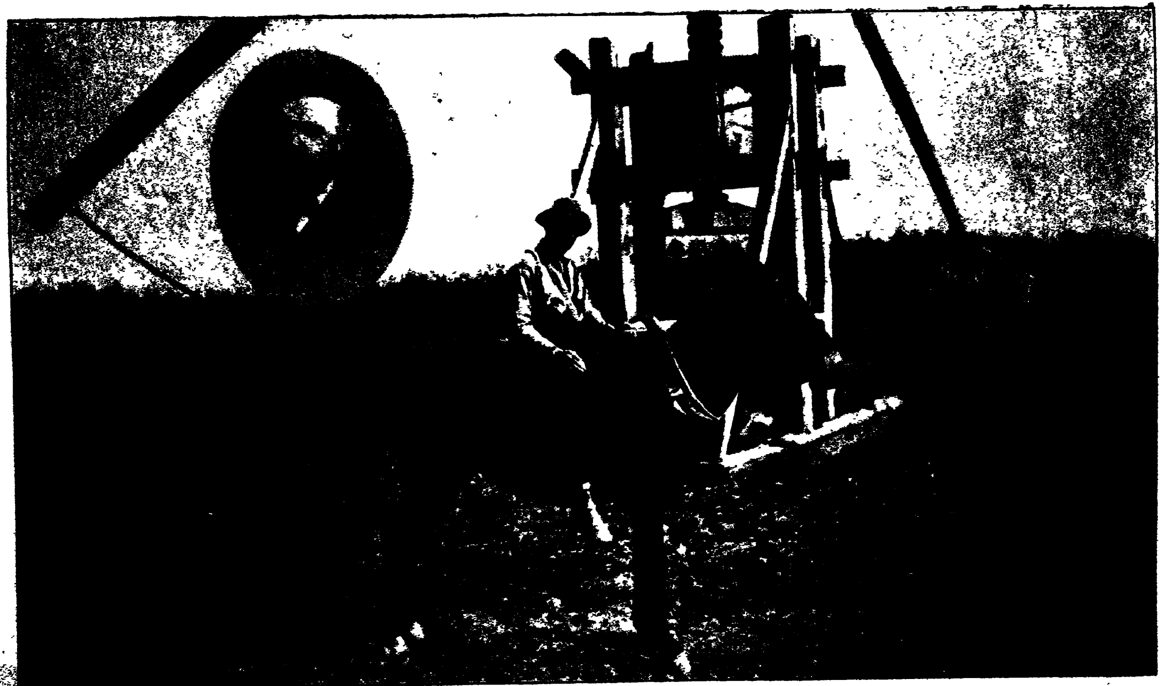


FIG. 60. Cotton Planting Syndicate.—Planter, Negro, Mule.

Carpet Bag Government.

For ten years, even at high prices, no profit was made in growing cotton. For ten years the confusion—political, commercial, agricultural and social—was worse than confounded. Whole legislatures could be suborned for any corrupt purpose, and riots were frequent.

The corrupt leaders of the negroes organized them into militia companies, and infamous secret political societies, known as the Union League. The whites organized rifle companies and the Ku-Klux-Klan, which was a secret organization for resisting the corrupt actions of carpet bag governments.

In this period of ten years, and in spite of all this disorder, the whites and blacks were producing cotton; the white man owning the land and the black man working it. The schemes of work and compensations were various. Sometimes the planter would rent land to a negro tenant for a fixed quantity of lint cotton; sometimes for a proportionate part of the crop; and sometimes he would pay the hands agreed wages by the year. The longer the confused conditions lasted, the more unreliable the negro became as a laborer, although there were notable exceptions. It was the rule for them to drift into the idea that freedom meant license, and the franchise an asset.

New Basis of Compensations.

It would be impossible to give even approximately the different experiments in the way of contracts made by the white land-owners with the freedmen. A few are defined as follows:

(1) The landlord would furnish land and mules, receiving as rent and for use of mules, one-third the crop, the tenant furnishing his own living. Even in this case, the landlord would have to "advance" the supplies for a living, or guarantee the account with some merchant for these supplies.

(2) The landlord would furnish the tenant with land, mule and an agreed quantity of supplies, and they would divide the crop equally.

(3) The land-owner would contract with the laborer for a year, paying about $50 to $100 per year, and furnishing supplies as agreed.

(4) The land-owner would rent land to a tenant for a fixed quantity of cotton. A farm of 30 acres would rent for about three bales of cotton, or about one bale for ten acres. These rent bales would be worth $30 to $40 each, equivalent to about $5 per acre for land. Although this would represent a good income on land worth $5 to $10 per acre, land was difficult to sell at these prices, because of the precariousness of collection. The negro tenants were generally unreliable.

After 1876, political conditions were very much improved. The negroes had also acquired some education and some knowledge of what freedom really meant. Those who had formerly been planters had acquired by experience some knowledge of the freedman, who, by the way, proved to be a totally different person from the slave, even though the same individual.

Industrial Renaissance.

With the restoration of political order, and the establishment of a better understanding between blacks and whites, the retrogressive movement of the last decade changed, and things began to look much better.

Cotton seed oil mills caught the attention of those who were progressive. These prospered with negro labor. On the farms, negroes still objected to working under overseers. In the oil mills, they made no objection to superintendents and foremen.

Cotton mills also began to be built, and these employed white labor exclusively. This gave profitable employment to a class who were in urgent need of it. These manufactures grew in an increasing ratio, and others were

formulated and established. Farmers found that the new factory populations made good markets for the perishable products of the farm, which before had been worth less. Gradually as these interests grew, all labor, white and black, became more reliable and more efficient. By the year 1900, there has developed in the Southeast, or Piedmont region, occupation at moderate compensation for practically all who are willing to work. To show the difference in income for an average county in 1880 and 1900, following figures are exhibited:

Assuming 10,000 bales of cotton as the crop of an average county, and taking the current prices of to-day as applicable to both, in order to show the comparison at even date, 10,000 bales of cotton at 6 cents would yield $300,000.00. This would represent the income of the people of the country for their cotton crop, when sold as raw cotton. Now this, if manufactured into cloth is worth $1,000,000. Instead of shipping out cotton to England and getting back $300,000, the cotton goes to the factory in the county, is made into cloth by home people, is sent say, to China, which sends back $1,000,000.00, thus making a profit to the county of $700,000.00. This assumes, of course, that the laborers live in the county, that the fuel is obtained in the county, (wood or coal), or that the power comes from water. The small supplies ordered from outside amount to very little, and may be omitted. The difference of $700,000 is not of course, all profit to the mills. It goes to pay labor, thus furnishing profitable employment to those who were formerly compelled to idle much of their time; it pays for wood or fuel, that formerly rotted; from the labor it goes to the farmer for food stuffs and to purchases from merchants and others. The ultimate division of this increased income to the county, is exhibited in Table IV.

TABLE IV.

SHOWING DISTRIBUTION OF PROFITS IN COTTON MANUFACTURING:

To farmers for beef, pork, meal, flour, chickens, eggs, milk, butter, vegetables, fruits and other perishable farm products	$250,000
To farmers for wood, labor, drayage and other service	50,000
To merchants for dry goods	100,000
To merchants for groceries	100,000
To stockholders for dividends	100,000
To lawyers, doctors, preachers, etc	50,000
To taxes, good roads, schools and churches	50,000
Total	$700,000

Besides living much better, all these beneficiaries save something, and at the end of the year, the country is richer instead of poorer.

This is by no means the limit of profit that can be brought out of cotton by manufacture. The above is simply the result of converting cotton into plain white and simple colored goods, all comparatively coarse. By special textile education and training, better and higher priced goods may be made. As the quality becomes improved, the money brought back from the markets of the world would materially increase.

Take the crop of North Carolina for one year, as an example, and it may be made into goods the market value of which are exhibited in Table V*.

*From "Cotton Values in Textile Fabrics."

TABLE V

SHOWING THE VALUE OF A NORTH CAROLINA COTTON CROP OF 500,000 BALES.

As cotton at 6 cents per pound.		If manufactured.
$15,000,000	Duck at 14c per lb .. ..$	35,000,000
15,000,000	Drilling at 16c.............	40,000,000
15,000,000	Sheeting at 18c.............	45,000,000
15,000,000	Bleaching at 20c............	50,000,000
15,000,000	Tick at 24c.................	60,000,000
15,000,000	Cheviot at 26c..............	65,000,000
15,000,000	Denim at 30c	75,000,000
15,000,000	plain Gingham at 34c........	85,000,000
15,000,000	Window shade cloth at 34c..	85,000,000
15,000,000	Madras at 40c	100,000,000
15,000,000	Long Cloth at 70c...........	175,000,000
15,000,000	Mercerized cloth at $1	250,000,000
15,000,000	Fancy gingham at $1.60	400,000,000
15,000,000	Poplin at $1.80	450,000,000
15,000,000	Emb. ginghams at $2.20.....	550,000,000
15,000,000	Fancy ginghams at $2.80	700,000,000
15,000,000	Persian lawn at $4.00	1,000,000,000
15,000,000	Embroidery at $20..........	5,000,000,000

Cotton Seed Oil Mills.

In a similar way, the cotton seed oil mills take cotton seed, which were formerly worthless, and turn them into products having good values. In the cotton growing States, the values gotten out of cotton seed 20 years ago. were all together not over $5,000,000. At the present time the ultimate values reclaimed from cotton seed products will reach nearly or quite $100,000,000. Numerous other industries have developed, and these, all taken together, support a large population, who receive good

wages, and in turn, buy the perishable farm products. Thus, with these helps, a farmer can make cotton and sell it for 6 cents a pound at a profit, where formerly, without these supplemental markets, he would have lost money.

In addition to these influences, that are advantageous to the cotton farmer, the cotton States have been wise and liberal in all legislation about agricultural experiment stations, boards of fertilizer control, agricultural colleges, and other measures that contribute to the farmers' knowledge of the science and art of cotton production. While the price of cotton has been constantly decreasing, and the quantities increasing, all the above influences have been tending to keep its production on a profitable basis.

Those farmers who are near the new manufacturing centres, can now produce cotton as cheaply and profitably as the ante-bellum planter could with slave labor. He can sell enough farm products, other than cotton, to cover all cost, and have the cotton as a clear profit. This naturally makes land more valuable; and it is notable that land in the vicinity of all new factories increase in price, with great rapidity, to twice and thrice their former values.

Because of slavery before the Civil War, and because of the disorders thereafter, the cotton growing States have not attracted much immigration from the class that wanted to farm. The adverse conditions seem now totally gone. In the conditions, now existing in the cotton growing States, that land which is near a factory population, offers greater attractions to working farmers than the farm lands of any other part of the United States. The old condition of being able to make a cotton crop as a clear profit has returned, and the opportunity is well within the reach of a man of very limited means.

Advent of the Small Farm.

The negro has become again a good and tractable workman, provided he works along with a white man,

and he is now available as a helper to a good farmer. Land is rapidly increasing in value, and the future is attractive, even if the crop of cotton is large and the price cheap. The profits in cotton planting in this new condition, are not to be made by planters or landlords who own large tracts of land; but are only available to the thrifty working farmer. By handling a cotton farm on the same plan as the wheat and corn producers of the Northwest, and with negro labor, still cheap, and now become very reliable, (when one or two negroes work along with the white man), cotton may be produced with greater economy, and probably with more profit, than ever before in its history.

These favorable conditions for the small farmer have led to the sub-division and sale of many plantations, and this tendency is continuing, thus promoting a multiplicity of small farms.

Part II.

COTTON OIL.

COTTON PLANT AS IT APPEARS IN SEPTEMBER BEFORE FIRST PICKING.

CHAPTER X.

Cotton Seed.

The American cotton plant grows to variable heights. On uplands, and where full grown, it is sometimes not more than 15 to 20 inches high. Generally, on uplands, it is 24 to 48 inches high. On the black prairie lands of Texas, it grows from three to six feet high, and in the rich alluvial Mississippi bottoms, its full height is five to eight, and sometimes even ten feet.

In Southern Texas and Florida cotton begins to open in the early part of August. In much the greater part of the cotton belt, picking generally begins about September 1st.

One of the colored plates shows a cotton plant as it appears in September. It is in full vigor of growth, and the bolls are just beginning to open. The leaves are deep green. The blooms are a light yellow when they first come out, and become light pink under the influence of the sun. The plant continues to bloom and fruit throughout the autumn, until very chilly nights or frosts check further development.

Another plate shows the plant about November 1st, when the chilly nights give to the leaves the color of autumn foliage.

At a later period, during December, the leaves have become withered and have fallen to the ground, leaving the last of the open bolls with cotton hanging from them ready for the last picking, as shown by another plate. The immature bolls, caught and killed by the frost remain on the stalks or fall to the ground.

Half a bale of cotton to the acre is ordinarily good production. The average of the whole cotton-growing area is about one bale to three acres. Reckoned at half bale to the acre, the production of seed to the acre would be

about 500 pounds, or about 16 bushels. The seed from upland cotton weigh 30 to 33 1-3 pounds per bushel, according to the manner in which the measure is packed or heaped. The legislatures of different States fix the weight of the legal bushel at different figures, varying from 30 to 33 1-3 pounds. Buyers of cotton seed frequently ignore the legal bushel, and buy in a way to give them some advantage, as, for example, in paying for them by the (heavy weight) bushel, and selling them by the ton.

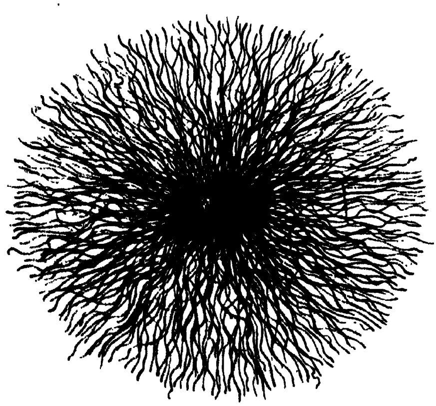
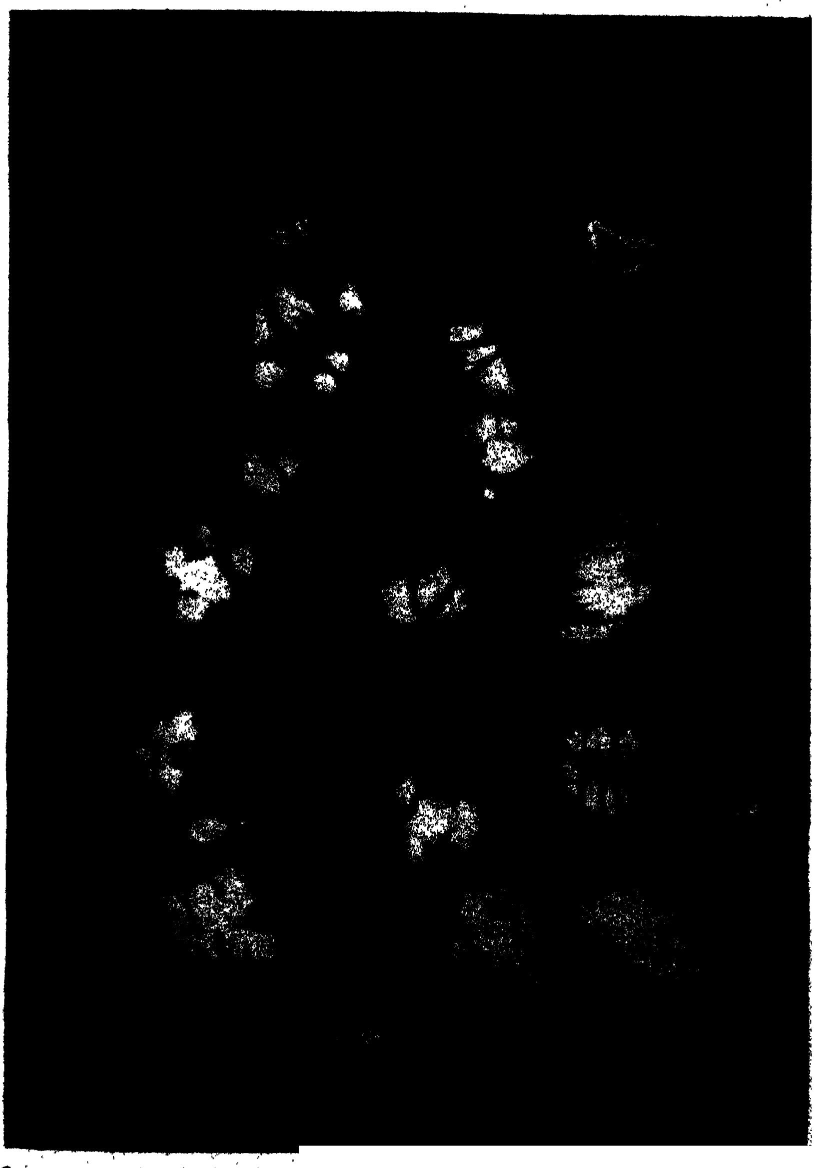


FIG. 61. Cotton Seed, Showing How Lint Grows.

The total cotton crop of the United States is about ten million bales. For every pound of cotton produced, there is an average of two pounds of seed. Therefore the seed from which the cotton for a 500 pound bale is taken, weigh about 1,000 pounds. The seed from the entire crop would be about five million tons. This is half a ton of seed per bale of cotton.

American cotton seed are of two kinds, viz: upland, and Sea Island, or black seed. Lint cotton has the appearance of growing out of the seed as the human hair grows



THE COTTON PLANT AS IT APPEARS IN OCTOBER
AND NOVEMBER.

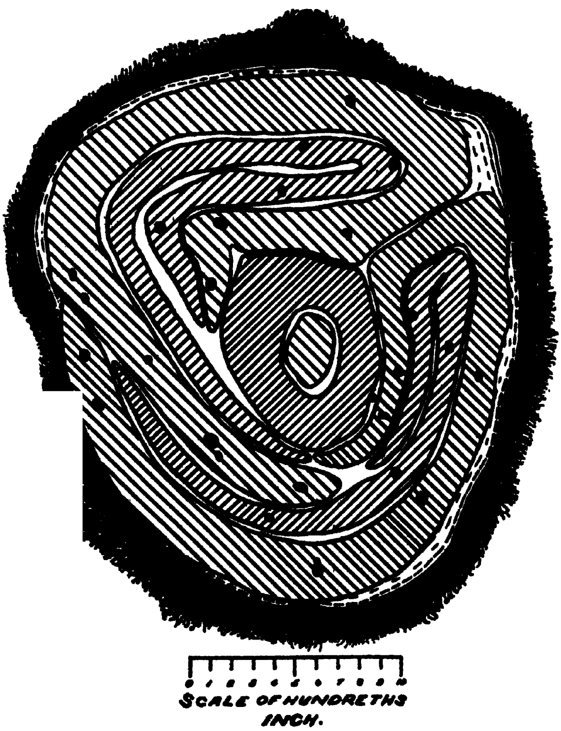


FIG. 62.

Cross Section of Cotton Seed Magnified 12½ Times.

out of the head, or as wool out of a sheep's back. See Fig. 61.

The lint of upland cotton holds very tenaciously to the seed. In ginning it, the fibres break near the point of attachment to seed. This ginning requires a saw gin. The seed from the gin have a fuzzy appearance, and are slightly greenish in color.

The lint from Sea Island cotton comes entirely loose from the seed very easily, thus leaving seed smooth and black. These seed are called "Sea Island," or "black seed," or "baldheaded seed."

Figure 55 shows the empty boll with the seed cotton which comes out of it. (Cotton is in the picker's hand.)

Figure 61 shows the cotton seed, natural size, with all cotton removed from the front half, and the cotton fibres more or less straightened out on the middle plane. This figure shows a staple about one inch long. This is a fair average of good upland cotton. Upland cotton grows in all lengths from ½ inch to 1¼ inches. Mississsippi "Bender" cotton has a fibre 1⅛ to 1⅜. "Sea islands" grow 1½ to 2½ inches, 1¾ to 2 inches being the usual lengths for this variety.

Figure 62 is the cross section of a cotton seed magnified 12½ diameters. The black spots are oil cells. They seem very scattering, but it must be remembered that those shown are only the ones in the section through which the seed is cut.

The centre is a sort of stem, and in germinating the convoluted matter unfolds to make the beginning of the plant.

Nearly all the seed worked in oil mills are upland seed. A ton of these, as they leave the ginnery, and go to the oil mill, are physically composed about as follows after being cleaned:

Short lint	75 lbs
Hull	925 lbs
Oil (52 gals)	390 lbs
Meal	610 lbs
	2,000 lbs

THE COTTON PLANT AS IT APPEARS IN DECEMBER.
NEARLY READY FOR FINAL PICKING.

A good oil mill gets out of a ton of seed, products about as follows:

Short lint	25 lbs
Hull	1,000 lbs
Oil (40 gals)	300 lbs
Meal	675 lbs
	2,000 lbs

The foregoing estimates do not take into account sand and other foreign matter in seed. This is comparatively small. It varies, with the care in picking and ginning, from 1 to 5 per cent.

It will be observed that the separations are considerably short of perfection. Only about 25 pounds out of 75 pounds of the lint left on the seed can be profitably taken off. After this amount, the remainder is short and worthless, and is left to go with the hull. In the processes of crushing and manipulation, some of the hull and lint gets into meal, thus increasing the weight of the meal. This weight is still further increased by the oil which is left in it.

All market towns in the cotton growing States have "seed agents," in the ginning season. The oil mill companies construct seed houses and put up wagon scales at the railway stations. Some companies have 50 to 75 of them. These are small and cheaply constructed warehouses, capable of holding one to three or four carloads of seed. The mills send out representatives in August to arrange for agents to take charge of their seed houses and scales, and buy seed for them. These agents generally get $1 per ton for compensation. At good seed points, there are sometimes several seed houses, and of course several agents. Some merchants own seed houses, and buy seed on their own account, and sell them to the oil mills afterwards. Ginners also sometimes act as seed

agent for mills, and sometimes buy and sell seed on their own account.

In the Piedmont region of the Southeastern States, and adjacent uplands, there will be marketed in a good town, from farm wagons, two to four thousand tons of seed in a season. In Texas, a good market town will sometimes (though rarely,) handle as much as ten thousand tons.

The competition of the different local seed buyers is sometimes very keen, to the extent of much excitement. It is not uncommon to see two or more young white men —runners for seed agents or buyers—mount the wagon of a negro or white farmer, as he comes from the country into the market town. These press upon the farmer offers for the seed. Sometimes the drummers, or runners, even get into personal encounters. The oil mill managers are themselves good fighters in the seed markets, and they not infrequently sacrifice business judgment to the pleasures of purchasing a larger quantity of seed than some rival manager. Considerable quantities of seed are taken on wagons by farmers or ginners direct to the oil mills, when these are near by.

The seed bought in market towns, and there stored in seed houses, are shipped in bulk and in carload lots to the oil mills. They are brought to the warehouse by the farmers. These take cotton to the ginnery, pay for the ginning and baling, and then take the bale of cotton and the seed to market.

In Texas, there is a growing tendency for the large ginneries to buy the seed cotton, and when this is done, the ginner markets both seed and lint.

Great care should always be taken to protect seed from exposure to rain, and even from moisture. Slight moisture will cause heating and decay. A very few seed slightly wet or damp, if put into a seed house, will very soon begin to heat. The heating will extend to other seed, and decay sets in rapidly with great heat. This heat sometimes becomes so great as to make fire by spontaneous com-

bustion. Such a fire in the middle of a seed pile, does not break out, as an ordinary fire does, but simply smoulders. It is nevertheless disastrous in its effects on the seed. The oil from seed that have been heated, is not sweet or edible, but must be sold for soap making or other such uses. Seed, when found beginning to heat, are always given immediate attention by the good mill manager. They are at once fed to the mill. If there are more than the mill can take care of, they may be shoveled from one place to another to cool. This is, of course, expensive. The rule about an oil mill is that wet seed will not be purchased. When, however, a farmer is caught in a slight rain, with a load, the mill man will usually strain the point, buy the seed, and send them at once into the mill to be worked.

It is a question whether water or fire does the greatest damage to seed. For this reason, it has never been determined whether for fire protection a seed house ought to be equipped with automatic sprinklers or not.

Some large mills work 30,000 to 50,000 tons of seed per year, and have storage for 10,000 to 15,000 tons. With such quantities in the warehouses at one time, the importance of having all stored seed perfectly sound and dry will be apparent.

The seed from the early part of the season do not keep as well as those of the second and third pickings. The early seed have most sap. On this account early seed are much more liable to heat. For this reason, such of these early seed as are stored, are worked out of the warehouse early, and the space then filled with seed of later growth.

The quantity of oil in cotton seed varies greatly. The quantities are different on different soils, and also different in different seasons. The quality of the oil also varies. Sometimes seed from a certain section will yield, in an average oil mill, 42 gallons per ton, the oil having a sweet, palatable flavor. In another season, the same soil may produce a seed that will yield only 35 gallons per ton, and the quality of the oil may not be as good.

It is no rule that large quantity and good flavor go together, nor is it a rule that small yield makes oil of inferior quality. The quantity and flavor seem to depend on independent influences. Experts differ in opinion on these points. Many good oil mill men claim that large yield and good oil are usually found together. Other good mill men claim that a wet season makes seed that give larger yields, but these seed, because of sap, are more liable to heat and therefore make inferior quality of oil.

CHAPTER XI.

Cotton Seed Oil. History and Commercial Features.

From time immemorial, the praise of the olive tree has been sung, both in sacred and profane literature. For centuries before and after the Christian era, it was held, and is still held, in the highest esteem. This high estimation in which the olive tree is held, comes undoubtedly from the fact that in its fruit and oil, mankind has heretofore obtained more that is useful than from any other plant or tree.

It was an olive branch that the dove brought back to Noah in the ark, to give courage and hope to survivors of the flood. The olive branch is well nigh an universal emblem of peace among all peoples.

In ancient times, and in many countries still, olive oil is the principal, and in many cases the only cooking grease. Our Anglo-Saxon habit of using animal fats in its stead, is the exception, and not the rule. In The Arabian Nights, the story goes, that forty thieves were concealed in jars that were supposed to contain oil.

Throughout the same ages, the cotton plant has always existed; but, remarkable as it may seem, its value was never fully understood, until within the past 25 years.

The three prime necessities of the human race are: food, clothing and shelter. Towards these, the olive tree furnishes its fruit and oil for food, and in a very limited extent its wood for construction. The cotton plant now supplies lint, from which clothing for the body, the bed and household (carpets) is made. It supplies oil for cooking purposes, and for many industrial uses, such as for lamps in mines, and to a limited extent for lubrication, for making soap, glycerine, candles, butter, lard, and for innumerable other uses.

The cotton seed meal is used for supplying ammonia and other constituents in commercial fertilizers, for cattle food in dairies, for fattening beef, sheep, and for various other purposes. Lately, however, it is being mostly used as a food for cattle and sheep. This is especially the case at dairy farms, and where cattle are being fatted for beef, and at saw mills, where oxen are used to haul logs.

In truth, we are suddenly brought to a realization of the fact that the cotton plant gives us more than the olive tree ever gave to mankind. And, by perfecting machinery and methods for the production of useful products from cotton seed, values which have for centuries been unknown, have suddenly been brought to light. The men who have been most instrumental in the production of valuable products from cotton seed, have been doing a work not only for themselves, but for the country at large, and for all humanity

The First Cotton Seed Oil Mills.

The first mill was built at Natchez, Miss., in 1834. A Mr. Martin operated a cotton seed oil mill in New Orleans as far back as 1847. But few other mills were built prior to the Civil War. Immediately after the Civil war of 1860-65, several mills were built, some of which succeeded, and some failed.

In 1869 General E. P. Alexander built a cotton seed oil mill at Columbia, S. C. Following this, other mills were built in different parts of the cotton growing area. By 1880, the business of crushing cotton seed had developed into a distinct and entirely legitimate business, but the process employed, and everything pertaining to the industry was held in great secrecy.

The oil was found to be about the same as olive oil, and the cake and meal was largely exported and used in England, and on the Continent, for stock food. What was purchased in America was principally used as a fertilizer. The oil was used principally as a substitute for, or an adul-

FIG. 63. General View 150-Ton Oil Mill, 1885

terant of, olive oil, and readily sold in the crude state, at from 50 to 60 cents per gallon.

Those mills that were managed with even a rough approximation to ordinary care and business judgment made very large profits. As the business still developed and the price of oil became less, the pork packers discovered that it could be advantageously used with certain beef products to make an excellent cooking fat, to take the place of hog lard. Since its adaptation to this use, large and increasing quantities have been consumed by concerns that slaughter cattle and dress beef for market. Since about 1880, the consumption of cotton seed oil has been further increased by its use for packing sardines on the coast of Maine, for making butter in America, Holland and elsewhere, and for numerous other purposes.

The Machinery Used.

The principal machinery used in early cotton seed oil mills was brought from England. It no doubt comprised such heaters and presses as were used to crush oil from linseed, Egyptian cotton seed, and other oil seeds that were produced in or shipped to England. Egyptian cotton seed are black and lintless, very similar to seed from Sea Island cotton in this country. The process of working them was very simple They were first crushed under old fashioned mulling stones, then put in steam jacketed kettles with mechanical stirrers, and cooked. The product was dumped from the kettle or heater into a wooden bin, and from the bin it was put into a hydraulic press containing about five boxes, and put under about two to three thousand pounds pressure to the square inch, on rams ten to twelve inches in diameter.

Upland American seed are not entirely free from lint. On account of the quantity of oil this lint is capable of absorbing, and also on account of the injury which the lint is to the cake as a food stuff, it was important to separate the hull from the meats. This was accomplished by the

use of a huller, a machine to cut the seed to pieces, and screening out the meats from the hulls, in bolting chests, having the reel clothed with wire cloth.

The earlier mills were either built by foreign mechanics, or native Southern mechanics of ante-bellum type, both of whom were dogmatic, opinionated and incompetent. It commonly required about two years for these to build a mill, and get it into successful operation.

The costs, profits, processes and all other information about an oil mill were kept carefully concealed by owners and millwrights or experts.

From 1882 to 1884, the subject was first looked into from an engineering point of view. In 1884, there was erected the first cotton seed oil mill ever built from designs made by the modern type of educated and practical American engineer.

Most of the seed worked in the United States are upland seed. The average physical composition of a ton of these upland seed as received at the oil mill is about as follows:

Short lint	70 lbs
Hull	910 lbs
Oil (51 gals)	382 lbs
Meal	600 lbs
Sand and other foreign matter	38 lbs
	2,000

These proportions vary with seasons, soils, character of ginning and care or conscience of the farmer, ginner or seed agent. By bad ginning there may be 125 pounds of lint left on the seed, and by very good ginning, the seed may be cleared of lint to within 50 pounds.

The best possible oil mill is one in which the separation of the above constituents is most nearly complete and put in marketable shape at the least expense per ton.

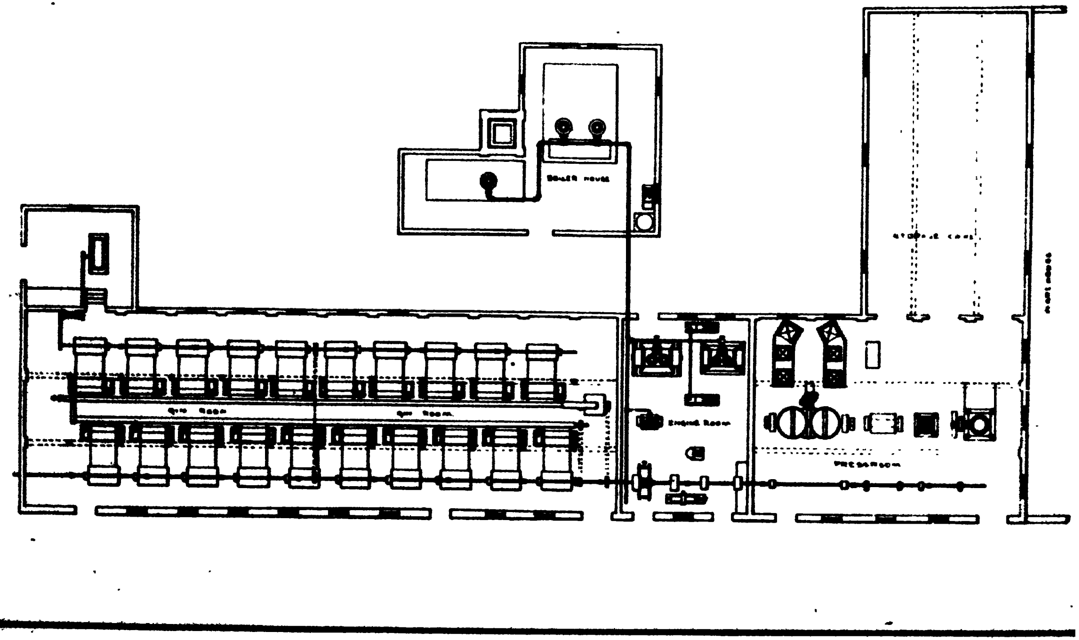


FIG. 64. Arrangement of Machinery, 150-Ton Oil Mill, 1885.

Process.

The process of manufacture in American oil mills underwent very little change until about 1880. From that time forward, great improvement has been made in machinery, such as improved hullers, improved linters, steel plate boxes in presses (requiring no hair mats), chilled rolls in place of muller stones, etc, etc.

The process now conducted in first-class mills is about as follows:

1. The seed are cleaned of sand.

2. Then cleaned of the other foreign substances, such as bolls, pieces of wood, etc.

3. They are then carried to the linters, and re-ginned for a part of the short lint.

4. They are then carried to the huller, which cuts them to pieces.

5. Then in a reel the meats are separated from the hulls.

6. The hulls are then taken out, heretofore to the fire room for fuel, but latterly to be sold as cattle feed.

7. The meats are taken to the rolls which crush them, breaking the oil cells.

8. From the rolls, the meats go into heaters, in which they are cooked.

9. From the heaters, meats are taken into the former, where cakes are formed and enclosed in cloth.

10. The cakes are placed in the press and the oil extracted by pressure.

11. The cake remaining in the press is taken out, allowel to cool, and may then be cracked and ground into meal.

The following tables will exhibit the variety of results from operating various kinds of oil mills, under different conditions.

TABLE VI.

SHOWING PRODUCTS AND VALUES OBTAINED FROM ONE TON OF SEED IN THE EARLY OIL MILLS:

1,000 lbs hulls, used as fuel		$ .30
775 lbs meal @ 90c		6.98
225 lbs oil=30 gallons @ 60c		18.00
2,000 lbs seed, giving product worth		$25.28
Cost of seed	$10.00	
Cost of working	5.00	$15.00
Profit		$10.28

A mill of this design capable of working 5,000 tons of seed per year, should therefore have made, and often did make, with good management, $50,000 per year.

At the present day, meal remains at about the same price shown in the above table. Oil, however, has declined fully half. By improved mills and machinery, the cost per ton of working seed has been much reduced, and the quantity of oil per ton has been increased.

Many mills exist that can never be made first-class, except by entire reconstruction. Of the mills still being built, there is much variation in the quality of the design and workmanship on the machinery.

TABLE VII.

SHOWING PRESENT PRODUCT AND VALUES OBTAINED FROM ONE TON OF SEED IN AN OLD OR BADLY CONSTRUCTED OIL MILL, IN A GOOD YEAR.

Oil, 39 gals at 30 cents per gal		$11.70
Meal, 675 pounds at $1.00 per cwt		6.75
Hull, 950 pounds at $3.00 per ton		1.42
Lint, 25 pounds at 3c		.75
		$20.62
Cost of seed delivered at mill	$14.00	
Cost of working, bags, barrels, etc	3.50	
Cost of fuel	1.00	18.50
Profit		$2.12

A mill under these circumstances, working 5,000 tons of seed per year, could therefore make a profit of more than $10,000.

TABLE VIII.

SHOWING PRESENT PRODUCTS AND VALUES OBTAINED FROM ONE TON OF SEED IN AN OLD OR BADLY CONSTRUCTED MILL, IN A BAD YEAR.

Oil, 35 gals at 20c		$7.00
Meal, 675 pounds at 90c per cwt		6.08
Hull, 950 pounds at $3.00 per ton		1.42
Lint, 25 pounds at 3c		.75
		$15.25
Cost of seed delivered at mill	$12.00	
Cost of working, bags, barrels, etc	3.50	
Cost of fuel, per ton	1.00	16.50
Loss		$1.25

A mill under these circumstances, working 5,000 tons of seed per year would lose over $5,000.

TABLE IX.

SHOWING PRESENT PRODUCTS AND VALUES OBTAINED FROM ONE TON OF SEED IN WELL DESIGNED MILL WITH THE BEST MACHINERY, IN A GOOD YEAR.

Oil, 40 gals at 30c		$12.00
Meal, 675 pounds at $1.00 cwt		6.75
Hull, 950 pounds at $4.00 per ton		1.90
Lint, 30 pounds at 3c		.90
		$21.55
Cost of seed	$15.00	
Cost of working, bags, etc	3.00	
Cost of fuel	.50	$18.50
Profit		$3.05

A mill under these circumstances, working 5,000 tons of seed per year would make a profit of about $15,000.

TABLE X.

SHOWING PRESENT PRODUCTS AND VALUES OBTAINED FROM ONE TON OF SEED IN A WELL DESIGNED MILL WITH THE BEST MACHINERY, IN A BAD YEAR.

Oil, 40 gals at 20c		$8.00
Meal, 675 pounds, at 90c		6.08
Hull, 950 pounds at $4.00		1.90
Lint, 30 pounds at 3c		.90
		$16.88
Cost of seed	$12.00	
Cost of working, bags, etc	3.00	
Cost of fuel	.50	15.50
Profit		$1.38

A mill under these circumstances, working 5,000 tons of seed per year, would make a profit of nearly $7,000 This would be a dividend of 14 per cent. on a capital of $50,000 in the worst year. This shows the value of first-class designs in an oil mill.

These figures are all average estimates. There is, of course, great variation in prices at different times, and in prices at different parts of the seed territory. They apply also to the oil mill business, without supplemental or auxiliary adjuncts, that are now coming into vogue.

As a matter of fact, the best modern concerns in the East comprise in one plant, a ginnery, oil mill, fertilizer works and cotton mill, each department helping the other.

In the operation of an oil mill, the personality of the manager and his capacity to make quick and accurate decisions on commercial points, has a greater influence on the profits than is the case in most other businesses.

Hulls for Fuel.

Throughout the entire South, the use of hulls for fuel has been totally abandoned, and they are being used as stock food, many mills having added the business of fattening cattle for beef The use of hulls and meal together has been thoroughly demonstrated to be excellent for fattening cattle for beef, and also for feeding dairy cattle. These combinations have been, in fact, so perfected in design that several plants have been built to put the seed cotton as a raw material through a complete cycle of operations, as follows:

1. Separating the lint from the seed.
2. Separating the short lint.
3. Separating the hull and meat.
4. Separating the oil and meal.
5. Mixing meal and other ingredients for fertilizer.
6. Feeding hulls and meal to cattle, using the manure as a fertilizer.
7. Spinning and weaving the lint, making yarn and cloth.

Thus, taking seed cotton as a raw material, the products are taken out that are valuable for clothing and animal food, and what is useless for these purposes is returned to the soil, to make the new crop.

Table XI. exhibits the value that might be obtained from the seed from ten million bales of cotton, if manufactured under the ordinary improved processes now in common use, and sold at current prices.

FIG. 65. General View 200-Ton Oil Mill. 1887.

TABLE XI.

SHOWING VALUE OF ORDINARY MANUFACTURED PRODUCTS OF COTTON SEED FROM TEN MILLION BALES OF COTTON.

200 million gals oil (40 gals per ton from five million tons) at 30c..	$60,000,000
Two and a half million tons hulls at $4.00..	10,000,000
One and two-thirds million tons of meal at $21.00	35,000,000
100 million pounds lint at 3c	3,000,000
Total	$108,000,000

The total seed crop of 1900 as disposed of by ante-bellum planters would not have been worth $5,000,000, as against more than $100,000,000, if utilized according to the present known methods of obtaining values out of them.

But the values indicated in the above table represent even much less than the possible results.

Two and a half million tons of hulls will fatten for market two and a half million heavy beef cattle, or would maintain a proportionate number of dairy cattle.

From these cattle come beef, tallow, glue, all dairy products, and still further developed industries. The oil, besides being used as a cooking oil, gives also glycerine, candles, soap, lard, butter and indefinite other products and industries. Notable as an example of one of the uses to which it goes: The cylinders of the phonograph are made from the "soap stock" residue in refining cotton oil

Delinting Machinery.

There is a legend in the oil business that there is a fortune in store for the man who invents a means of cleaning the lint from upland cotton seed so that they have the appearance of Sea Island or Egyptian seed. The country is full of inventors trying to make seed cleaning machines. Most of the workers at the problem have never stopped to ask the question where the fortune would come from, or why it should even be expected that there would be profit in a perfected delinting machine. Many machines have been invented and made—quite a number of good ones, but nobody has yet made the fortune.

Whenever any evidence is exhibited at all in support of the assertion or idea that a delinting machine would be valuable, the argument is about as follows: The price of seed in America is $10.00 per ton; in England it is quoted about $24.00 per ton Therefore, if a machine could be invented to make American seed look like the Egyptian, there would be a fortune it.

As a matter of fact, when seed are quoted at $10.00 in this country and $24.00 in England, the meaning of a ton in this country is 2,000 pounds, and in England 2,240 pounds. If this be considered, and there be added to the cost of seed in this country the cost of cleaning, freight to port, ocean freight, handling and commission on the other side, and freight to mill on the other side, it will be found cheaper to work seed in America by the usual American process. The seed from the American sea island cotton are already clean, and are already near ports in most cases, and yet no important business has ever been developed in shipping them abroad. The reason is, that if they can be purchased at a reasonable price, it pays better to work them in this country than to attempt to ship them.

Linting.

Much has been said about the value of the lint that is not true. After seed are well linted by an ordinary linter,

what is left is of not much value as fibre or paper stock

A good linter gets from 20 to 30 pounds of lint from a ton of seed, when about five tons per day is put through one machine. It is a considerable question whether it is worth the cost to take more than 30 pounds of lint from average seed.

Assuming the ability of the linters to get say 30 pounds of lint per ton, the linters may be so arranged as to run the entire seed first through one half the linters, getting fifteen pounds per ton, and then run them through the other half, getting fifteen pounds more. The first lint would sell for say 4 cents per pound, making 60 cents per ton. The second lint would bring say 2 cents per pound, making 30 cents per ton, making a total of 90 cents per ton.

On the other hand, running the seed through all the linters at one time would give, say 30 pounds of uniform quality, which would sell at about 3 cents per pound, making 90 cents per ton also. The question of profit would depend more on the market to be reached than upon anything in the mill.

Storing Cotton Seed.

Cotton seed are very perishable, and the danger of heating might be estimated at 10 per cent. of their value. By care, this may be reduced to 5 per cent. or less.

A mill having a capacity of 30 tons of seed per 24 hours, and a storage capacity of 1,000 tons of seed, from the 15th of September to the 15th of February, would work about 3,000 tons; allowing for breakdowns and holidays.

To work 5,000 tons instead of 3,000 may be accomplished by increasing storage capacity to the extent of 2,000 tons, making 3,000 instead of 1,000, and using the same machinery; or it may be done by leaving seed storage unchanged, and adding additional machinery to work the 2,000 tons additional seed in the same time.

By adding storage, there would be the following items of additional expense:

1. Liability of seed to rot or damage.

2. Interest on money invested in 2,000 tons stored seed.

3. Less oil per ton on stored seed than on seed worked fresh.

4. Less price on oil out of stored seed, if in any way heated.

5. Additional labor for working same tonnage for a longer time.

6. Interest on increased warehouse cost.

By adding new machinery there would be the following additional expenses and advantages:

1. Interest on value of additional machinery.

2. Repairs on additional machinery.

3. Less cost per ton, because the same force can usually operate the additional machinery and make the increased output in the same time.

4. The meal can be put on the market for the current year, instead of part of it having to be carried over to another season.

By having ample mill capacity, as against large storage capacity, and working seed practically as fast as received, banking facilities become a much simpler matter, and in all respects the manufacture is facilitated and cheapened. But there is a limit to the profitable capacity of a single mill. It is believed that the most profitable size mill ranges from 25 to 100 tons capacity, according to locality and amount of seed available. Mills larger than this become difficult to manage. One of the difficulties consists in the handling of the large amounts of seed which come by rail, during the short season in which seed are marketed. If larger capacity than 100 tons per day is desired, it is better to build two or more separate mills.

It is a good rule in any manufactory to keep on hand the least raw material necessary for regular running, and to sell products about as they are ready for the market.

To accumulate raw material is to speculate in it, and to hold the products is equally speculative; and a factory is not necessary if speculation is the object. It is best to accept whatever profit there is in manufacture at current market prices of raw material and products, and when current market prices yield no profit, shut down and wait for one or the other of the markets to change. By this plan it is always easy to determine what a factory can afford to pay for raw material.

Whenever a mill is not in condition to operate, by being unfinished or otherwise, it is especially dangerous to accumulate seed. If it seems desirable to purchase them, they should be bought and sold as a mercantile transaction but not held to wait completion of a new mill, or repairs on an old one.

Most Profitable Size of Mills.

There are two ways in which the cotton oil business may be made to pay. (1) Build a large mill in a railroad centre, where it is easy to draw large quantities of seed from a large territory. (2) Build a small mill in a small town, with scant railroad facilities and depend mostly on wagon seed, and depend on home demand for all of the products, except oil. The large mill has to work harder for its supplies of seed, but is not hampered by local competition in any one place, because if seed should become too high in one town, it can easily abandon that town and find another one.

In the matter of disposing of products; by reason of having large quantities to dispose of, the large mill is in good shape to supply to the export market and thus make large sales as easy as small sales. But the advantage which a large mill possesses that outweighs all the others, is that the volume of its business will justify it in employing competent men who will be able to turn out the very highest class products, and who will be able to carry the process very much further than less com-

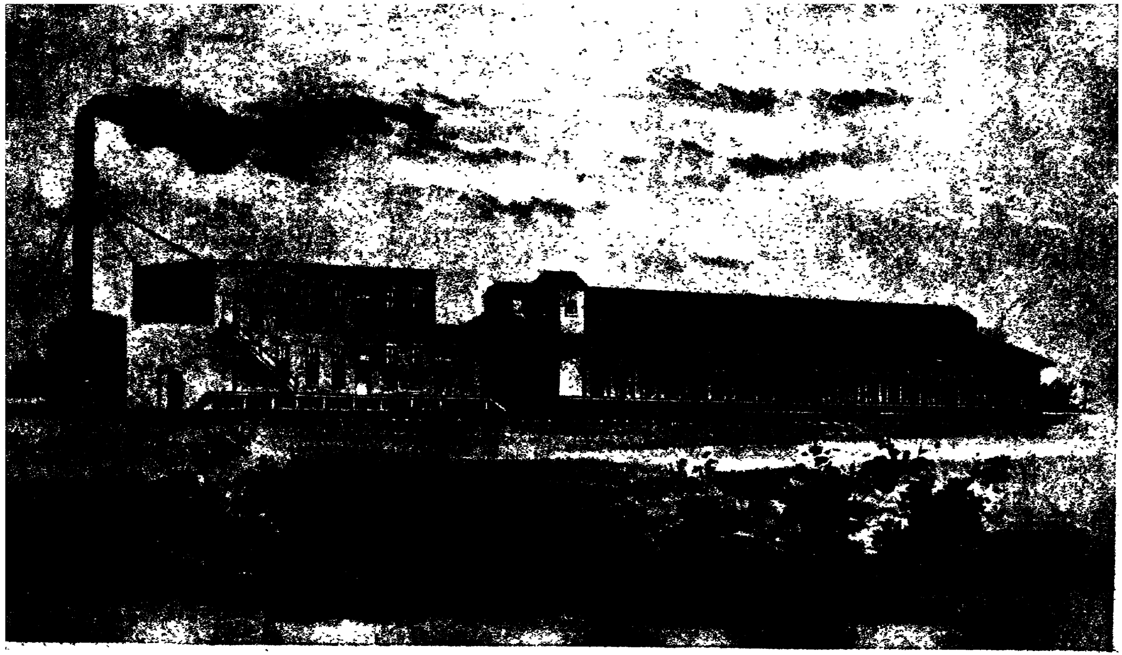


Fig. 66. General View 100-Ton Oil Mill, 1890.

petent men. This would consist in refining the oil, making soap, etc., also in making fertilizers and stock feed.

On the other hand, the small mill has distinct advantages of its own. These advantages have become accentuated of late years since the value of meal and hulls for stock feed has become better known. This gives the local mill a local market for all of its products except oil, that is to say, about 85 per cent of the weight of the cotton seed.

In the matter of purchasing seed, it has little or no freights to pay, and generally has the co-operation of neighboring farmers. It is sometimes possible to exchange mill products for seed, thus enabling a small mill to operate on the minimum amount of capital. These small mills vary in size from 20 to 40 tons of cotton seed per day of 24 hours. They generally consume from 2,000 to 4,000 tons of cotton seed in one season.

The large mills in railroad centres have capacities ranging from 100 to 150 tons of seed in 24 hours, and consuming from 10,000 to 20,000 tons of seed in one season.

The small local mill idea is growing in popularity, and some predict that it will finally take possession of the field. But there is ample field for the large central oil mill, provided the business is worked out to a logical extent and more attention paid to producing finer products at higher prices. It may even reach a position where it can purchase the oil from the small local mills, and make much profit by turning this oil into high price products.

In all kinds of manufacturing, the cost of raw material forms a smaller and smaller percentage of the value of the mill products, as these mill products become finer in quality. For this reason, variation in the cost of raw material is of the least consequence to a mill turning out the finest or most finished products. This is exhibited by the following examples:

EXAMPLE (1.) ORDINARY PROCESS.

		Per cent. of value of products.
Cost of seed.......	$12.00	67
Cost of working....	3.00	17
Cost of product....	$15.00	84
Value of product—crude oil, meal, hulls	$18.00	100
Profit......	$ 3.00	16

EXAMPLE (2.) AMPLIFIED PROCESS.

		Per cent. of value of products.
Cost of seed.......	$12.00	30
Cost of working.....	20.00	50
Cost of product....	$32.00	80
Value of product—butter oil, salad oil, compound lard, butterine, beef ...	$40.00	100
Profit	$ 8.00	20

It will be seen from the above examples that in the first case a rise in the price of seed means a rise on 67 per cent. of the value of the product, and that a rise of $3 would destroy the profits.

But in the second example, a rise in the price of seed only affects 30 per cent. of the value of the product, and a rise of $3 would only cut down the profit from 20 per

cent. to 12½ per cent. It would require a rise of $8 per ton on seed to destroy all the profit.

These examples show that refinements in manufacturing depend more on knowledge and skill than upon raw material.

It is believed that there is but little difference in the profits between operating a 100-ton mill in a railroad centre, and operating a 40-ton mill in a small town surrounded by cotton plantations. The distinct advantages of each are about offset by distinctive disadvantages.

The hundred-ton mill is able to operate on somewhat less expense for labor and fixed charges; but it must pay freights on hulls and meal to the consuming markets.

The forty-ton mill operates with somewhat more expense for labor and fixed charges; but it has practically no freight to pay on seed or hulls and meal.

At the present time, there seems to be more profit in operating mills within the limits of 40 to 100 tons capacity than those either smaller or larger.

The following table shows complete cost or capital investment necessary for cotton seed oil mills, refineries and cotton ginneries.

TABLE XII. SHOWING COST OF OIL MILL PLANTS.

Capacity for 24 hours, in tons.	Buildings, including Oil Mill, Boiler, Seed and Meal houses.	Land and R. R. Switch and Water Supply.	Press Room Machinery F. O. B. Factory.	All other Machinery in Oil Mill to make crude oil; and plans.	Freight and Erection.	Total Oil Mill, Boilers and Seed and Meal house.	Refinery, including building and all machinery; and plans.	Total Oil Mill and Refinery.	Ginnery, Six Stand Gins, and Cotton Warehouse, and plans.	Total, Oil Mill, Ginnery and Refinery.
10 to 15	$ 5 000	$ 1.000	$ 4,500	$ 5,000	$ 2,000	$ 17,500				
20 to 30	10,010	2,000	6.400	8,500	4,500	31,400	$ 11,600	$ 43,000	$ 15,000	$ 58,000
30 to 40	10.000	2,000	8,200	10,000	4.800	35,000	15 000	50,000	15,000	65,000
60 to 80	15,000	2,000	12,500	22 000	8,500	60.000	25,000	85,000	15,000	100,000
100 to 120	22,000	2,500	18,500	34,500	12,500	90,000	35,000	125,000	15,000	140,000

The estimates in table XII. are based on refineries designed to turn out a variety of products, such as summer yellow, butter oil, white oils and miners' oils.

If it is desired to make winter oils also, the cost would be increased about 50 per cent. If only summer yellow oil is to be produced, the cost would be about 50 per cent. less than the table.

The cost of a crude cotton seed oil mill may be said to be about $1,000 per ton (of seed in 24 hours) capacity.

The cost of refinery of about the character contemplated in Table XII. ranges from $300 to $500 per ton capacity of the crude oil mill.

Transportation and Uses of Cotton Oil.

The final test of cotton seed oil is edibility. The highest prices can only be obtained on this basis. When the quality of an oil falls below this, it goes into other uses and brings lower prices. In the early days of the business, this oil was looked upon entirely as an adulterant. It was shipped to Italy and France as an adulterant for olive oil, and was shipped to the lard works or "packing houses" of the United States, as an adulterant for lard. These uses still continue, but are growing into more general favor on the merits of the oil itself. There is still some prejudice against it, and justly so when used as an adulterant. But commerce is becoming accustomed to "compound lard," and "lard compound," and other names suggestive of the mixed character of the product; and the business of making acceptable culinary articles from cotton seed oil has become legitimate and desirable. Some of these compounds contain pure hog lard; while some contain none at all, and are advertised as such. It is estimated that 30 per cent. of the cotton oil produced in the United States is consumed in this manner. Most of the packing houses, where these lard compounds are made, are in the West. This business has recently commenced to grow in the South.

Formerly, owing to lack of skill at the oil mills, the oil was shipped in the crude state, to these distant works, where it was first refined and then utilized. Latterly, the mills have begun refining the oil before shipping, thus making the additional profit.

Oil is sold nominally by the gallon, but actually by the pound. The commercial gallon of cotton seed oil, crude or refined, weighs 7½ pounds. When oil is sold, the net weight is divided by 7½ in order to reduce it to gallons. In practice, this would often leave awkward fractions, so the custom is to multiply the weight by 2, and divide by 15, thus leaving any fraction as 15ths.

Previous to about 1886, the standard package for both crude and refined cotton oil was second-hand kerosene barrels. These were cleaned with hot steam, until they had no odor of kerosene, and were lined with glue to ensure tightness. If the work of cleaning is properly done, this makes an acceptable package. As the business grew, many became careless in cleaning the barrels, and many used varnish barrels and linseed oil barrels. This engendered a prejudice against all second-hand barrels. At the same time, the demand for second-hand kerosene oil barrels became greater than the supply, and within a very short while, it became the standard practice to use new barrels.

The use of tank cars for domestic shipments has been steadily superseding barrels. Most of the packing houses own large numbers of tank cars, which they send out to oil mills for their oil. Most of the large mills also own tank cars, in which they ship their product, and which they often use for purchasing crude oil from small mills, which are not equipped with refineries. Tank cars for cotton oil generally hold 6,000 to 7,000 gallons, or 45,000 to 52,500 pounds. This is the most convenient way to transport oil of all grades. They are also, to some extent, being used for soap stock, or the residues from refining.

Tank cars are provided with coils of pipe on the inside,

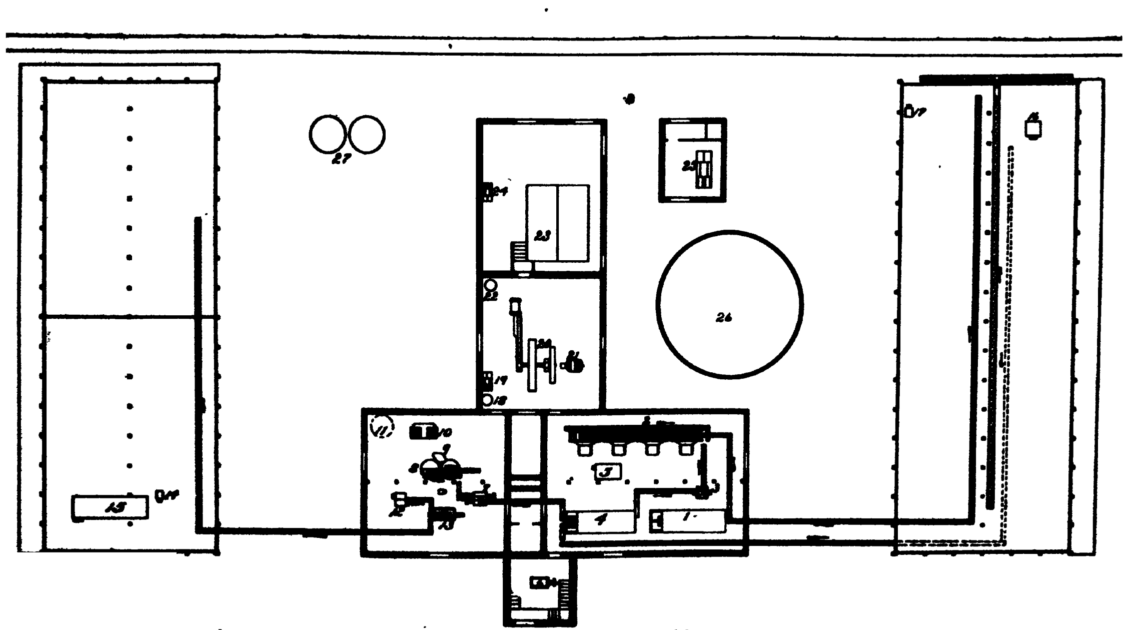


FIG. 67. Arrangement of Machinery, 40-Ton Oil Mill, 1901.

so arranged that hot steam may be used to thaw out the oil when it is congealed by cold weather. It is important to see that these coils are always in good order, so that no steam may be blown direct into the oil.

Oil for export must, of course, be put up in barrels. It is essential that the barrels be first-class, otherwise there will be great loss from leakage under the numerous handlings which they undergo.

A small amount of oil is now being exported in tank steamships, arranged to carry it in bulk, in compartments. These ships ply between Southern ports of America, where there are large storage tanks, and certain ports of Europe, where there are similar facilities.

About 65 per cent. of all the cotton oil produced in the United States is exported. About one-third of this, being the best grades, goes to Holland, for use in making artificial butter, which reaches its perfection in that country. The finest grades of summer yellow oil are known in the trade as "butter oil." Some of the best grades of oil also go to Southern European ports for admixture with olive oil, and also, to some extent, for an edible oil under its own name. South Europeans have always been accustomed to eating olive oil, as other people eat butter, and the poorer classes accept cotton oil as a cheap substitute. Large quantities of inferior grades, being about one-third of all our exports, go to Marseilles and neighboring ports for soap making.

Inferior oils are frequently bleached by sulphuric acid at the refineries into "white oil," and used as an illuminant, in place of lard oil. The principal use of this oil is for admixture with petroleums of high flashing point, to be burned in miners' lamps. This grade of white cotton oil is generally known as "miners' oil." It should not be confused with prime white oil, which is bleached from first quality summer yellow, by the use of fullers earth, and which is used in compound lard.

There are many minor uses for cotton oil, among which

may be mentioned the packing of sardines and similar fish. It has been frequently tried as an adulterant for linseed oil, or as a substitute for it, in painting. The difficulty has always been, that in its natural state, cotton oil will not dry out and leave the paint hard. Numerous processes have been exploited for making it into a drying oil; but none have so far been a commercial success. It has often been tried as a lubricant, but its gummy nature prevents any success in this field, except for the most ordinary purposes. Several processes have been tried for removing the gum or resin. There have been some laboratory experiments, which seem to indicate that a useful gum may be extracted and used as a substitute for rubber, while leaving the oil in a condition to use as a lubricant, but as yet, these processes have not been commercially successful.

Transportation and Use of Cotton Seed Meal.

When the oil has been extracted by hydraulic presses, there remains the cake. Formerly, when the presses were differently constructed and the processes were somewhat different, this cake was softer than it is at the present time. It was largely exported as cake, and sold for cattle food. It was broken into pieces and fed, in connection with other material. In some cases it was ground fine, after being exported, and fed in this condition. It has been found that the finely ground meal mixes more readily, and is more digestible than cake, and so the practice of feeding cake has been nearly abandoned. The Germans were the first to realize the value of fine grinding. From the beginning of the business, very small quantities of cake, and large quantities of meal were exported to Germany, while England and other countries preferred cake. In some cases this preference for cake was caused by the fear of adulteration in meal.

Cake was formerly packed into coarse second-hand gunny sacks and driven in with a mallet, in order to

make a firm package. These packages varied in weight, but generally weighed about 200 pounds.

Meal for export is ground very fine, and bolted clean. It is generally put up in 100 pound sacks, as one-twentieth of a "short ton" of 2,000 pounds; but for special orders it is sometimes put up in 112 pound sacks, as one-twentieth of the "long ton," of 2,240 pounds, and sometimes in 110 pounds sacks, as 50 kilograms. All meal for domestic trade is put up in 100 pound sacks.

The domestic demand was at first entirely as a fertilizer, both for use direct on the soil, and for mixing with other ingredients to make a commercial fertilizer. This demand grew to immense proportions in the Southeastern States, where fertilizers were universally used. From 1880 to 1890, about 90 per cent. of the meal made in that section was used for fertilizer, about 5 per cent. was exported, and the remainder was fed to cattle.

In the Southwest, where but little fertilizer was required, about 75 per cent. of the meal and cake was exported to Europe for cattle feeding, while the remainder was fed to cattle, at home.

At the present time, cattle feeding has become such an extensive business, both in the Southeast and Southwest, that of the whole amount of meal produced in both sections, about 35 per cent is fed to cattle, about 35 per cent. is used for fertilizers, and the remainder is exported for feed.

It has been so clearly demonstrated by experiment stations, and by other practical tests, that the principal value of cotton seed meal lies in its feeding, rather than its fertilizing qualities, that it is only a matter of time when practically all of the meal will be fed. The fertilizer works are already accommodating themselves to this condition, and are partly substituting other sources of nitrogen for the cotton seed meal.

The sacks, in which meal is shipped, consist largely of second hand wheat sacks, made originally to hold 100

pounds of wheat for export from California to the Orient. These sacks are often re-shipped with linseed to Eastern ports of the United States. When the linseed is used, the sacks are cleaned and put up in bales of 1,000, and sold to cotton oil mills. Fertilizer factories and cattle feeders frequently return sacks to the oil mills, to be used again and again. Meal is sold by gross weight, that is, no deduction is made for the weight of the sacks.

It is very difficult to empty absolutely all the meal from the sacks, and hence the returned sacks are somewhat heavier than they were at first, so that notwithstanding their damaged condition, necessitating repairs, the oil mills are always willing to allow consumers the full price of new sacks for all those returned.

Transportation and Uses of Cotton Seed Hulls.

The first use of cotton seed hulls was for fuel to run the oil mills. Mills of forty tons (seed) capacity, and upward, always made enough hulls for a full supply of fuel, even with very ordinary steam plants; with good, economical engines, there was considerable surplus; the larger the mill, the greater the surplus. It soon became a problem to dispose of this large amount of useless product. It was difficult to even give it away. The bulky and light nature of the material, made it difficult of transportation, and so it was not of much fuel value to other plants located at a distance from the oil mill. A ton, in its loose state, occupies about 300 cubic feet, and is equal in fuel value to one-quarter ton of coal, which occupies about ten cubic feet.

The use of cotton seed hulls as a cattle food was tried experimentally in the early days of the oil mill, but its true value, in comparison with other food stuffs was not realized until 1885 to 1890. About this time, systematic cattle feeding commenced, as an adjunct to oil milling in the Southwest. Large herds of Texas cattle were bought at low rates, and fed in pens near the mills, and when fat, shipped to the packing houses. The value of hulls as a

cattle food was thus practically demonstrated on a large scale, so that there arose a steady demand for hulls from many sources, all over the cotton growing States. The problem of transportation then began to receive attention. Hulls were at first shipped in bulk in box cars. By careful tramping, about twelve tons may be loaded into a car. Many hulls are still shipped in this way, some are put up by machinery into sacks; but the most general method is to pack them into bales about two feet square, weighing about 100 pounds. In this shape, 15 tons may be easily and quickly loaded into a box car.

The style of bale now in use is not entirely satisfactory, for the reason that it is only partially covered, and there is great waste in handling. There is a demand for some better method of packing cotton seed hulls for shipment.

TABLE XIII.

SHOWING VALUE AND AMOUNT OF SEED, CRUSHED, AND VALUE OF CRUDE MILL PRODUCTS, 1870 TO 1900.

Year.	No. of Mills.	Tons of Seed.	Value of Seed.	Value of Products.
1870	26	80,000	$ 640,000	$ 1,500,000
1875	25	150,000	1,500,000	2,900,000
1880	45	280,000	2,800,000	5,100,000
1885	80	550,000	5,500,000	9,800,000
1890	119	1,000,000	12,000,000	[illegible]3,800,000
1895	250	1,[illegible]00,000	21,500,000	[illegible]2,000,000
1900	400	1,800,000	[illegible]8,800,000	[illegible]5,000,000

CHAPTER XII.

Cotton Seed Oil. Mechanical Features and Processes.

The previous chapter outlined the schedule of oil mill operations. This chapter will discuss the machines for performing these operations.

Seed Handling Machinery—Conveyors.

Seed are moved horizontally by spiral steel conveyors, shown in Figure 68. Conveyors are right and left hand; as

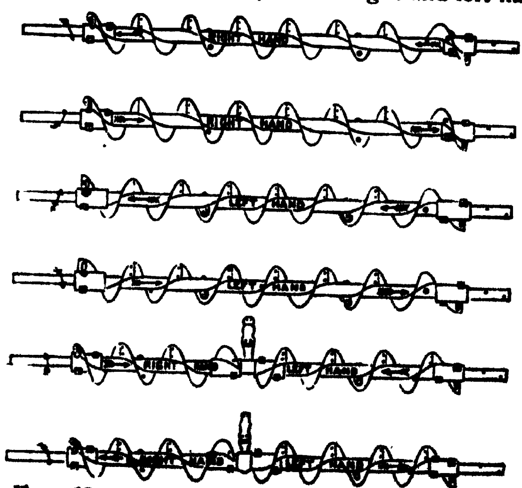


FIG. 68. Right and Left Hand Conveyors.

shown. Either hand conveyor may be made to carry seed in either direction, according to the direction it is made to revolve.

It is the best practice to have, as far as possible, all conveyors of the same size and hand in any one mill, in order to facilitate repairs, and the keeping of spare parts on hand.

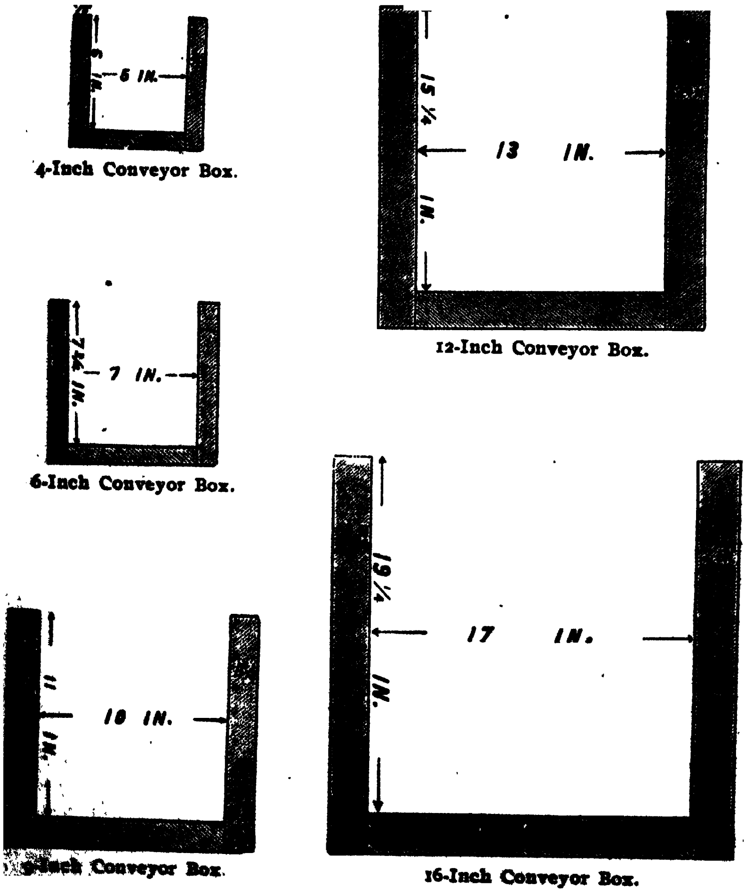


FIG. 69. Wooden Boxes for Conveyors.

Most mills use only right hand conveyors, except for special purposes, as shown in the last two examples in Figure 68. Mills of smaller capacity than 40 tons per day generally use 6-inch conveyors. Mills from 40 to 80 tons use 9-inch, while 12-inch is used in large mills. For the heavy work of unloading seed from cars in any size mill, the larger sizes are used, even up to 16-inch. The size of conveyors for this

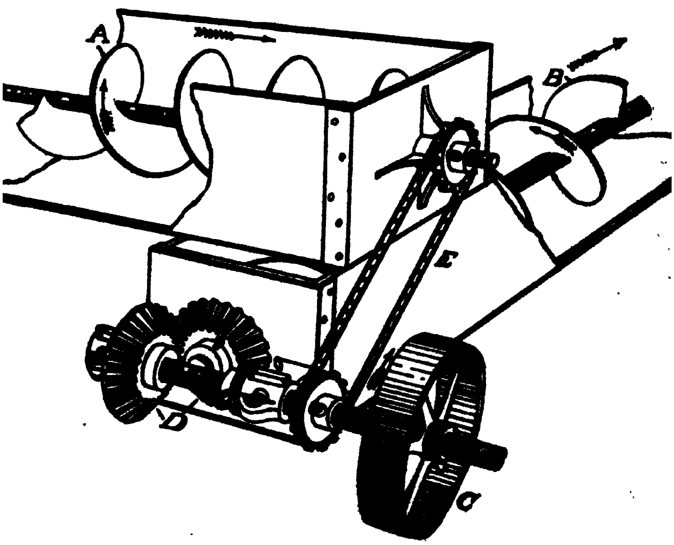


FIG. 70. Right Angle Conveyor Drive.

work is determined more by the amount of seed likely to be received by rail in a given time, than by the actual capacity of the mill.

Conveyors run in wooden boxes, lined in the bottom with sheet iron. Figure 69 shows the proper size to make boxes for conveyors.

A corner may be turned by the use of the device shown in Figure 70.

Conveyors may be run at an inclination of as much as 30 degrees from the horizontal, if occasion requires.

The following table shows the speeds and capacities of various size conveyors for use in oil mills. This data is based on the best practice; but it is possible to operate conveyors at 50 per cent. higher speeds, with corresponding increased capacities. It is also possible to run them as slow as may be desired.

TABLE XIV.

SHOWING SIZES, SPEEDS AND WORKING CAPACITIES OF STANDARD STEEL CONVEYORS FOR COTTON SEED.

Diameter Inches	Length Feet	Size Driving End Inches	Revolutions Per Minute.	Tons Per Hour
4	8	1	60	¾
6	10	1½	80	2
9	10	1½	100	4
12	12	2	120	8
16	12	2 or 3	120	12

Elevators.

Seed are moved vertically by elevators. The most common form is shown at the left of Figure 124. The pulley in the top should be 20 to 40 inches in diameter—the larger the better. For heavy work, such as unloading seed from cars, pulleys as large as 60 inches are sometimes used. The pulley in the bottom is usually smaller, say 12 to 20 inches.

The capacity of an elevator depends upon the size of the cups, their distance apart, and the speed of the belt. Oil mills smaller than 40 tons capacity generally use elevators with belts 6 inches wide, which carry 5x3 cups. Mills from 40 to 80 tons use belts 8 inches wide, which carry 7x4 cups, and larger mills use 10 to 12 inch belts, and cups in proportion. In all mills, the elevators for unloading cars are made large or small, (as in the case of conveyors), accord-

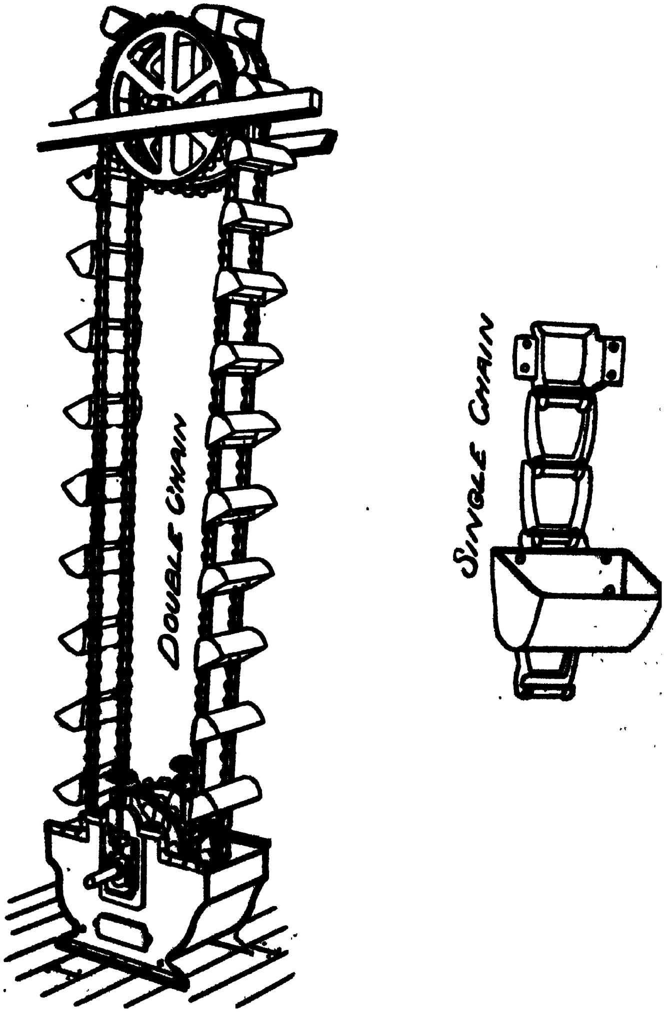


FIG. 71. Sprocket Chain Elevators.

ing to the amount of seed to be handled in a given time, regardless of capacity of the mill.

Elevators generally run 50 revolutions of head pulley per minute. They may be run as slow as 30 or as fast as 70.

Figure 71 shows two forms of sprocket-chain elevators, which are in use in many mills. It is mostly a matter of personal opinion whether the belt or chain elevator gives the best satisfaction.

It frequently occurs that the superintendent of a mill will prefer some special machine, on account of his familiarity and skill with it. Thus this machine is the best under his management. Another machine may be equally as good for the purpose in the hands of a man who is accustomed to it.

Receiving Seed—From Cars.

Seed mostly reach the mills loose in box cars. The cars are weighed on track scales, and run up alongside conveyors. Seed are thrown out into conveyor with broad, short pitchforks, or with scoop shovels. The conveyor delivers them to an elevator which takes them to the top of the seed house and delivers them to conveyors which distribute them over the house.

From Wagons.

Wagons usually drive up to the seed house and have their seed unloaded by hand through windows direct into the house. In some cases, where there is a very large wagon trade, there are unloading conveyors and elevators arranged on the same plan as for unloading cars.

The Milling Process—Cleaning.

The seed are brought from the seed house to the mill by means of conveyors and elevators.

It is necessary to free the seed from two classes of foreign matter: (1) Matter, such as sand, that is smaller than the seed; (2) matter, such as bolls and locks of cotton, that is

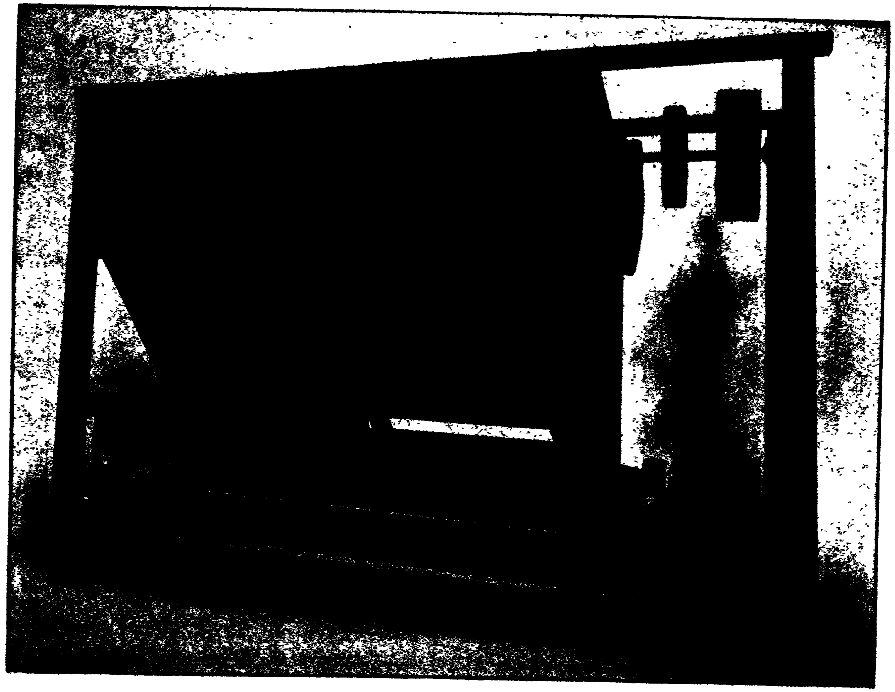


FIG. 72. Sand and Boll Screen

larger than seed. Both of these objects are accomplished by means of revolving screens, covered with perforated metal or wire cloth: In the first instance having perforations $\frac{1}{8}$" diameter, and in the second, $\frac{5}{8}$". Sometimes there is one screen for each of these operations, and sometimes the two are accomplished by one screen, having (longitudinally) half or two-thirds of its surface covered with $\frac{1}{8}$" perforations and the remainder with $\frac{5}{8}$". Such a combined boll and sand screen is shown in Figure 72. The interior construction is similar to Figure 124.

Seed enters at left hand, or higher end. Sand is removed by first part, and falls out behind. Clean seed fall into conveyor box. Bolls and other large particles fall out from inside of reel on the floor at the right. Sometimes magnets are inserted in the spouts to catch particles of iron. Sometimes fans are introduced under the screen, to blow the seed into the conveyor and leave iron and other heavy particles to fall out on the floor, as shown in Figure 73.

Sand and Boll Screen, Fig. 73—Lettering.

A.—Revolving reel.

B.—Spout where tailings fall out.

C.—Hopper to drop seed on shaker.

D.—Shaker to distribute seed in broad sheet over air blast.

E.—Shaft and eccentric to operate shaker.

F.—Fan.

G.—Blast box with perforated metal side to let out air.

H.—Gravity spout to catch nails and other heavy articles.

J.—Conveyor to take away the cleaned seed.

Mills of less than 40 tons capacity generally use a combined sand and boll screen, with the revolving reel about 5 feet diameter and 10 to 12 feet long. Mills of 40 to 60 tons capacity use combined sand and boll screen 5'x14'. Larger mills use separate sand screen and separate boll screen, 5'x14'.

The speed of the reel should be 20 revolutions per minute.

There are some other cleaning methods in rare use. One of them consists in revolving paddles inside of stationary perforated cage.

In many cases, the cleaning machinery is assisted by perforated sheet iron bottoms under the conveyors, which are used for unloading seed or for carrying them from seed house to mill. These are very valuable in sandy countries, where an unusual quantity of sand is found in the seed. This eliminates most of the sand before the seed are stored.

In the material collected from the boll screen is some good seed cotton. This is picked over by hand and ginned. The lint from this cotton is called "grabots." On account of the quantities of iron found in the material, which is liable to strike fire on the gin saws, it is quite dangerous to gin grabots. For this reason grabot gins should be isolated. Small mills usually have their grabots ginned at a public ginnery. Mills of 100 tons capacity and larger frequently have their own grabot gin.

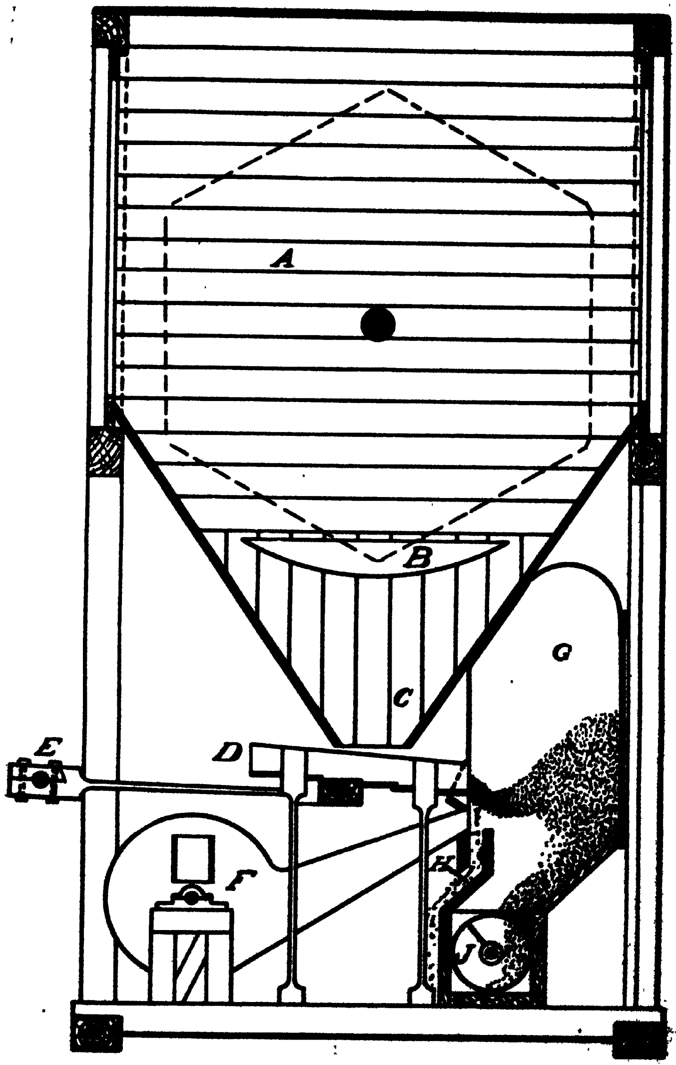


FIG. 73. End Section Sand and Boll Screen.

Linting.

From the cleaning processes, seed pass to the linters, which are machines for removing the short lint which is left on the seed by the gins. Figures 75 and 76 are general views, showing the usual arrangement of these machines. Seed are fed to the hoppers above, passed through the machine and taken away by the conveyor below in front.

Cotton Seed Linter, Fig. 74—Lettering.

A.—Feed box, with fluted feed roll.
B.—Breast, with revolving float.
C.—Saws on cylinder.
D.—Ribs between saws.
E.—Breast board to hold ribs.
F.—Brush to clear saws.
G.—Lint flue.
H.—Condenser, perforated drum.
J.—Compression roll.
K.—Roll of lint on core.

Process.

Seed are fed into feed box A.

Fluted roll feeds them regularly into breast, where float B keeps them revolving in a roll.

Saws remove the lint.

Brush clears the lint from saws and blows it against condenser drum.

Revolving drum condenses lint into a roll.

Ribs D hold the seed back and make them fall out at E.

Formerly the flue between linter and condenser was made long, and was provided with a slatted sub flue, for sifting out dust from the cotton, in its passage to the condenser, but it has been found that they were of no material advantage, and they are now made as short as possible, as shown in Figure 74.

There has been some effort made to introduce into the

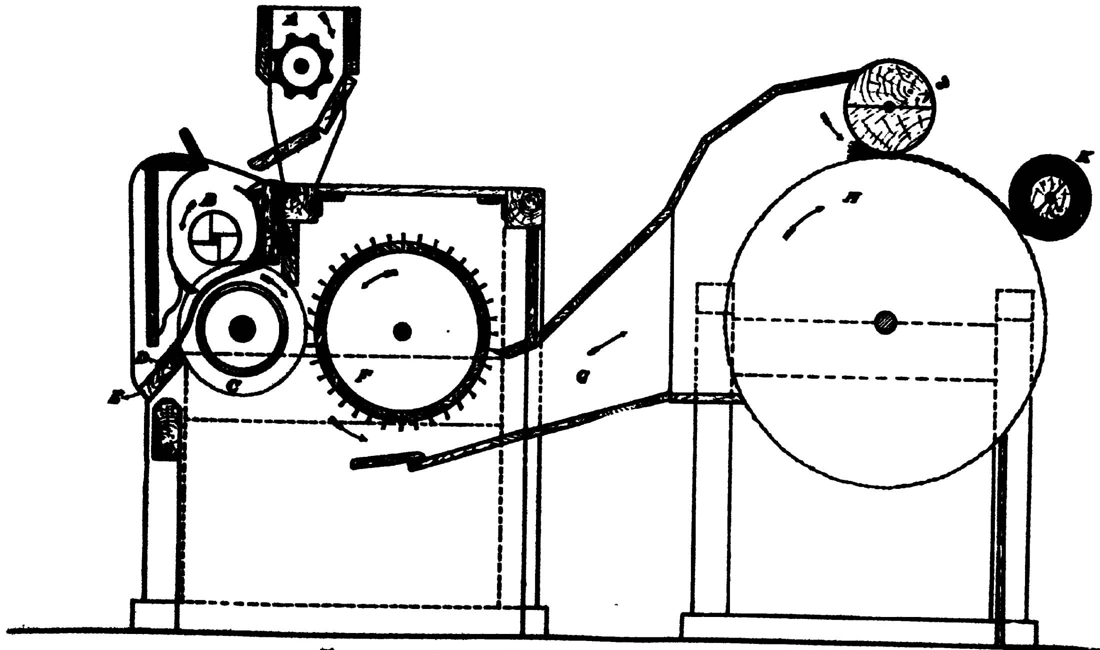


Fig. 74. Section Through Cotton Seed Linter.

larger oil mills the lint flue system, making one condenser serve several linters, as in cotton ginneries. This would have the advantage of cleanliness, most of the dust being blown out of the room through a dust pipe over the condenser. But up to the present time, the system has not been much used.

The capacity of one linter is rated at 10 tons of seed per day of 24 hours; but this may be varied from 3 to 15 tons, according to the speed of the feed roll. The slower this runs, and the smaller the amount put through, (generally speaking) the more lint may be taken from the seed. Most oil mills are so equipped that each linter takes 8 to 10 tons per day.

The speed of the saw cylinder should be about 350 revolutions per minute.

The saws of linters become quickly dulled, and thus lose some of their capacity to remove the lint. It is important to keep them well sharpened. Each oil mill should have a machine for sharpening linter saws, and there should be one or two extra saw cylinders, so that they may be sharpened while others are being used. For the greatest yield of lint the saw cylinders should not run more than one week without sharpening.

In the cotton gin, it is not permissible to have the saws too sharp, because they would then cut the fibres of cotton and make "gin cut cotton."

The saws must have teeth of proper shape, and somewhat smooth, in order to pull the lint off the seed, rather than cut it. But in the oil mill, it is necessary to have sharp teeth on the linters, in order to cut the short lint off the seed as closely as possible. The quality of this lint is not much depreciated by sharp teeth. This lint is really too short to be pulled off the seed, but must be cut off.

Formerly it was not considered necessary to sharpen linter saws more than two or three times in one season. The cotton gins did not clean the seed as well as they do now, and hence the oil mill linters made a good yield of lint, even

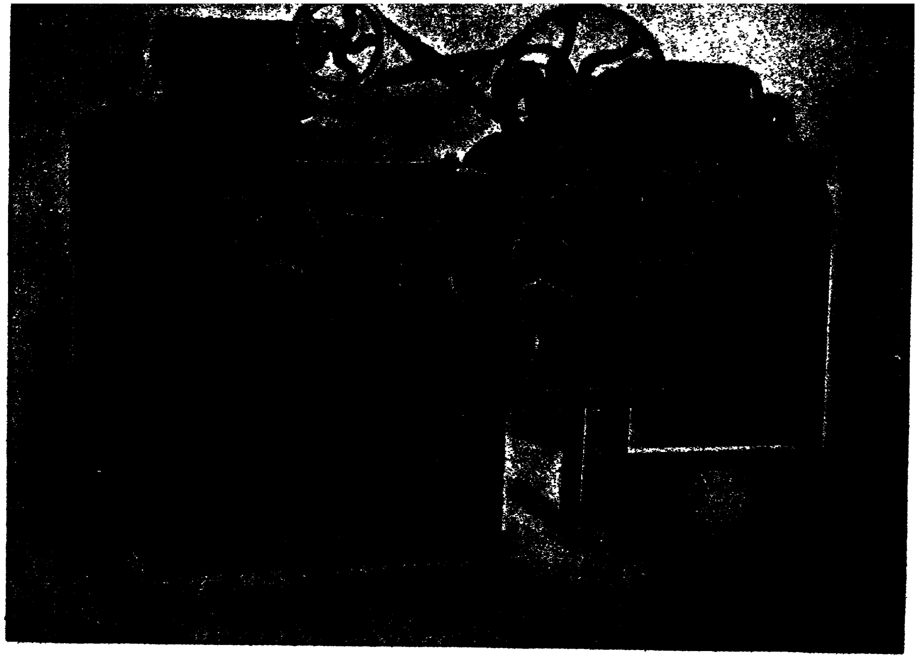


FIG 75. General View Cotton Seed Linter.

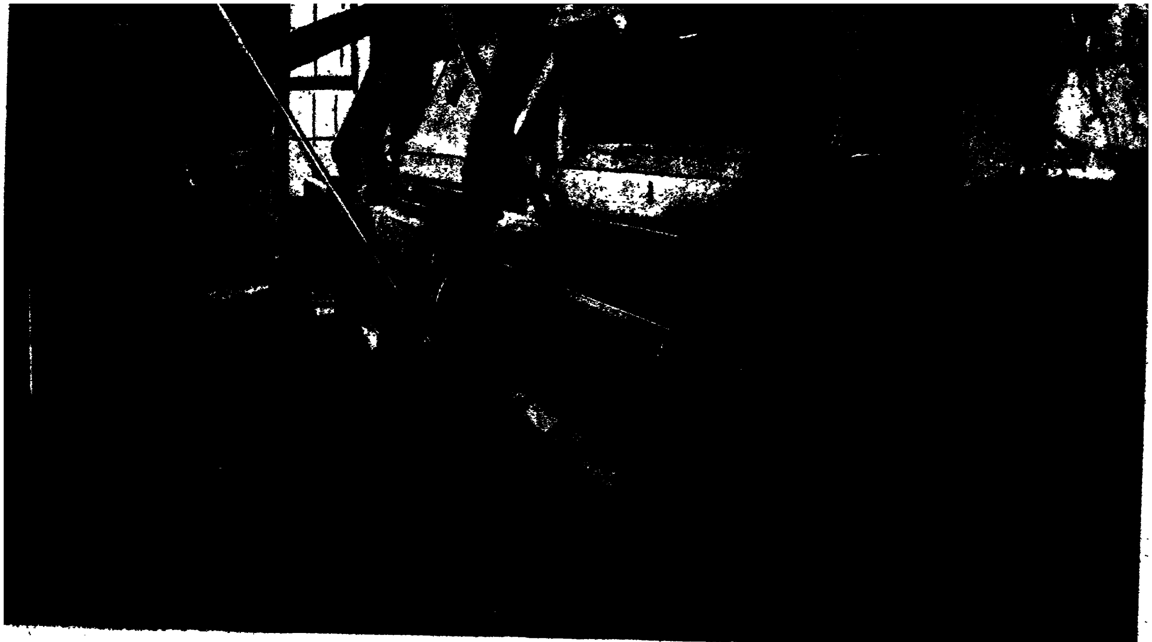


FIG. 76. Linter Room in Oil Mill.

FIG. 77. Cotton Seed Huller.

with dull saws. With the improvement in cotton ginning, it became necessary for the oil mills to make a corresponding improvement in the linting.

Huller.

From the linters, the seed pass to the huller, which is a machine for cutting the seed to pieces, so the kernel may be separated from the hull. There are two forms of huller in general use.

Huller Fig. 78—Lettering.

A.—Seed feeder. (See also Figure 81.)
B.—Revolving cylinder.
C.—Cylinder knives.
D.—Concave knives.
E.—Wooden staves to steady the concave knives.
F.—Clamps to hold the wooden staves in place.
G.—Conveyor to take away product.
H.—Balancing weights.

The cylinder knives have four cutting edges. One set of edges are used until dull, (say one to three weeks) when all knives are turned over, to bring another set of cutting edges into action. When all of the edges are dull, the knives are removed and ground. It is generally desirable to have an extra set of knives on hand, so that one set may be grinding while the other is in use. On account of the high speed at which the knife cylinder revolves, it is essential that it should be well balanced. In order to keep it so, the knives should be weighed, when reground, and steps taken to bring them all to the same weight by bolting on metal or drilling out metal. Besides doing this, after the knives have been bolted in place, the whole cylinder should be taken out and carefully put in place on straight edges by adjusting the balance weights which are inside the hollow cylinder.

The weights must be so adjusted that the cylinder is not

only in balance while standing, but also while running at its regular speed. It is quite possible to so adjust the weights in opposite sides and opposite ends, that the cylinder as a whole is in balance while standing, but when running at a high speed, each end might be out of balance on its own account, and the unbalanced centrifugal force would cause the machine to shake. In balancing a huller cylinder, on straight edges, it might be necessary to make several running trials before it is put in perfect running balance.

The "concave" knives also have four cutting edges, which are treated in the same manner as the cylinder knives. Each concave knive is adjustable to and from the line of cylinder knives by means of individual set screws. The usual method of procedure for setting huller knives is, when all are sharp, set up each concave knife, so the cylinder knife clears it about 3-32", and run the machine as long as it does satisfactory work, say three or four days, then set the concave knives closer, and run as long as it does good work, then turn another cutting edge on concave knives; then, when these are dull, turn a new edge of the cylinder knives, and so on, until all of the eight sets of sharp edges have been used. There can be no fixed rule about this procedure, however, because some seed are more difficult to cut correctly than others. The method used must be judged entirely by the result. Early in the season, when seed are full of sap, the knives must be very sharp, in order to cut the seed without mashing them.

At that time, the knives have to be set quite close, in order to cut fine, because the juicy meats adhere more firmly to the hull, and are harder to separate. Later in the season, when seed are dryer, it is better to run with knife space more open, both to save the knives and because it is not best to cut dry seed too fine. If cut too fine, much of the meats go to dust, and attach themselves to the lint on the hull, so that they cannot be well separated.

In grinding these knives, it is important to leave the edges parallel with the flat of the knife. Some superintendents

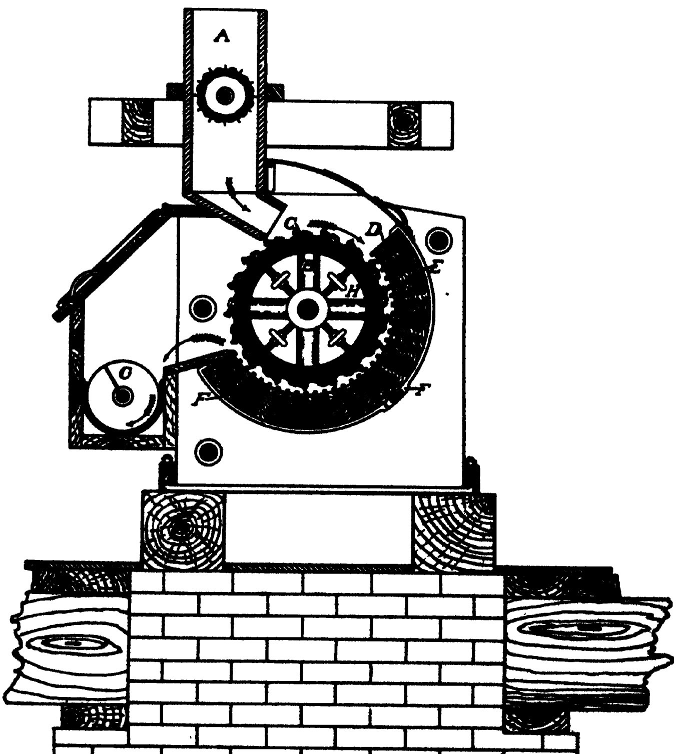


FIG. 78. Section Through Huller.

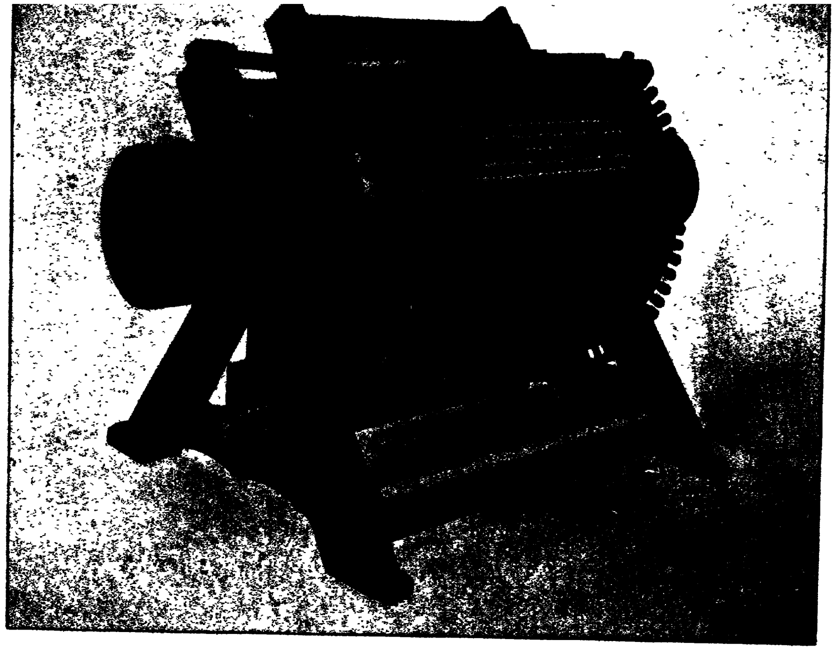


FIG. 79. Cotton Seed Huller.

erroneourly suppose that the edges next the line of bolts (in Figure 78) should be ground somewhat thinner than the outer edges, giving a concave appearance. In this case, seed are liable to lie in this depression, and pass without being cut.

This form of huller is made with knives 20 inches long, or with knives 30 inches long. The former has a rated capacity of 30 tons of seed per day of 24 hours, and the latter 60 tons. They will safely hull 50 per cent. more than this.

It is recommended that mills of more than 60 tons capacity have at least two hullers, either for the purpose of making the load lighter on each, or to run one to full capacity, and hold the other in reserve, in case of accident; and to run each of them alternate weeks.

The actual cutting capacity of a huller is many times the rated capacity. The point that practically limits the capacity is the delivery from the machine. When a huller chokes, from apparent overload, it is always found that the delivering side is choked. If the conveyor will keep the product away at all times, it is nearly impossible to choke a huller. In case of a choke, relieve the delivery, and then run the engine backward about one turn.

The speed of the 20-inch huller should be 1,300 revolutions per minute. The speed of the 30-inch huller should be 900 revolutions per minute.

It is not recommended to run them at lower speeds.

The stated speeds may be exceeded 10 per cent. without damage, if the cylinders are well balanced. They cut somewhat better at the higher speeds, but are more apt to give trouble.

Figure 77 shows a general view of this huller.

Another popular form of huller is shown in Figures 79 and 80. The principles of operation are the same as in the previous machine, but the mechanical construction is somewhat different.

Huller, Fig. 80—Lettering.

A.—Seed feeder (See also Figure 81).
B.—Revolving cylinder.
C.—Concave knives.
D.—Concave frame.
E.—Wooden staves to steady the concave knives.
F.—Adjustment for whole concave.
G.—Balancing weights.
H.—Point of delivery.
J.—Pivot on which concave is adjusted.
K.—Conveyor to take product away.

In this machine the cylinder knives are carried in radial slots in the cylinder, instead of being bolted on, as in the other machine. The concave knives are all adjusted at one time, by moving the whole concave frame, instead of by the individual screws, as in the other machine.

This form of huller is made in only one size, viz: With 30-inch knives.

The speed should be 900 revolutions per minute. This may be safely exceeded 10 per cent., but should not be decreased.

It has a rated capacity of 80 tons of seed per day of 24 hours, but may be forced to 50 per cent. beyond this, especially at the increased speed.

Knife Grinder.

Most mills are equipped with knife-grinding machines for sharpening huller knives. These generally consist of a large emery wheel and a self-operating carriage to which the knife is attached to be ground. Extra sets of knives are kept ground, ready to insert in the hullers when necessary.

Mills below 60 tons capacity rarely have knife grinders. They send their knives to a shop or a neighboring mill to be ground.

The earliest machines invented for hulling cotton seed, were provided with sharp knives like wood planer knives,

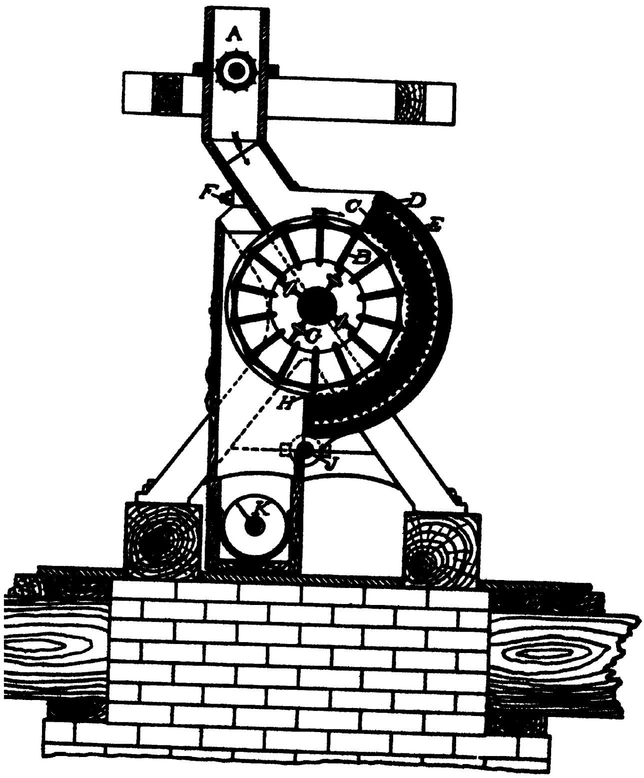


FIG. 80. Section Through Huller.

set in a revolving cylinder, or in a disc. These proved entirely useless. They would become dulled in a very short time, and the keen edges were not strong enough to withstand the foreign matter which always finds its way into a huller, no matter what process of cleaning precedes it.

Some hullers have been constructed with various forms of knife carried in revolving discs, sometimes horizontally, and sometimes vertically. But the two forms here illustrated and described are the only ones in actual use in first-class oil mills in the United States.

Separating Screen.

From the huller, the cut seed are conveyed to a revolving screen similar to the sand and boll screen. This has perforations 7-32" diameter. The meats pass through the perforations, while the hulls roll out as tailings. This screen rarely makes a perfect separation, and as the products leave it, there is still some meat in the hulls, and some hull in the meats. A variety of supplementary machines are in use for further separation, such as shaking screens, and revolving beaters in perforated cages, and conveyors with perforated bottoms. The most standard practice is to have a shaker directly under the screen, on which the meats fall as they come through the main screen. This shaker removes most of the remaining hull from the meats. The hulls which come from the main screen are carried to the place of storage or shipment in a conveyor having a perforated bottom, so that the meats yet remaining in the hulls are sifted through and removed by a smaller conveyor underneath. This arrangement is shown in Figure 82, where the hull conveyor is shown as right hand, bringing the hulls away from the screen, and the small conveyor left hand, carrying the meats back. It is usual to equip 40 to 60 feet of the hull conveyor in this manner. Sometimes this portion of the conveyor is made with cut flights, or interrupted spirals, for the purpose of stirring the hulls to perfectly shake out the small particles of entangled meats.

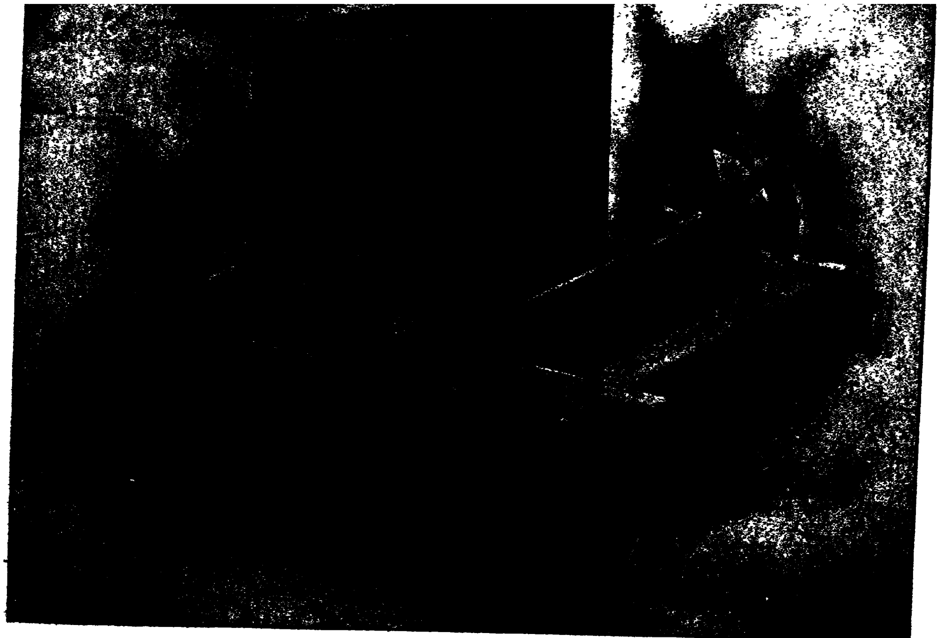


FIG. 81. Huller Feeder.

The capacity and speeds of separator screens are about the same as sand and boll screens.

The care to be given to the matter of perfect separation of hulls and meat is to some extent dependent upon the market conditions. Under any and all circumstances the greatest care should be taken to prevent meats from going away with the hulls. If some hulls go with the meats, they are finally sold with the cotton seed meal; and if the particular meal market supplied by the mill is not strict about quality, no harm is done. Usually, however, the cleanest meal is the most salable, and brings the greatest net returns.

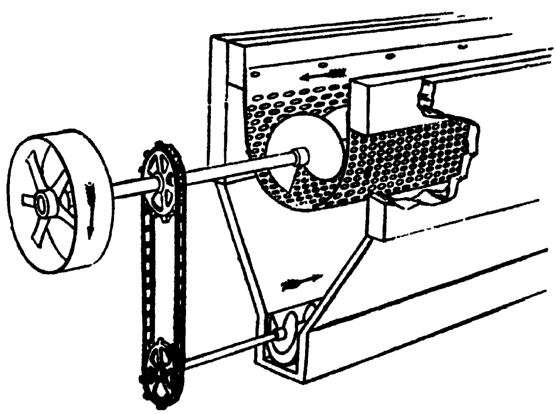


FIG. 82. Separating Conveyor.

Rolls.

From the separating screens, the meats pass to crushing rolls. Figures 83 to 89 show the various forms of rolls in common use. They all accomplish the same purpose in the same way, viz: By crushing the meats between the successive pairs of rolls. The various forms are shown to illustrate the different manners of driving the upper rolls from the main or bottom roll. All of the various methods are in successful use, and the particular method to be selected is mostly determined

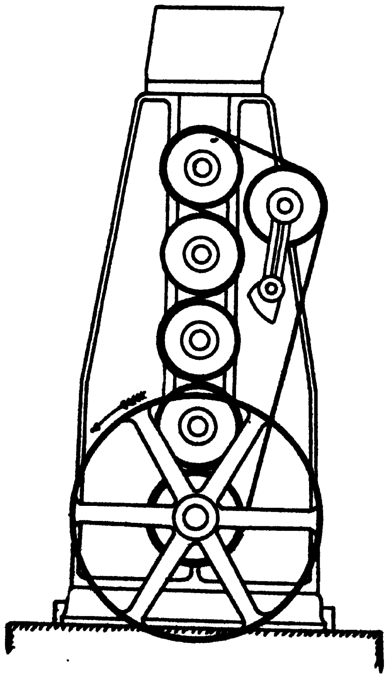


FIG. 83. Diagram Serpentine Drive for Rolls.

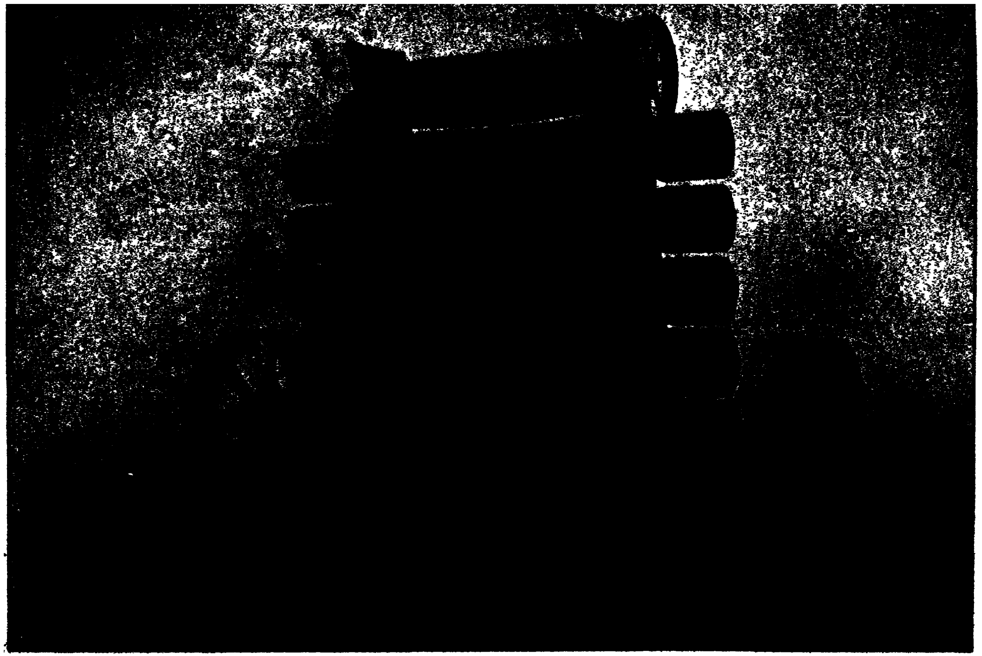


Fig. 84. Five-High Serpentine Rolls.

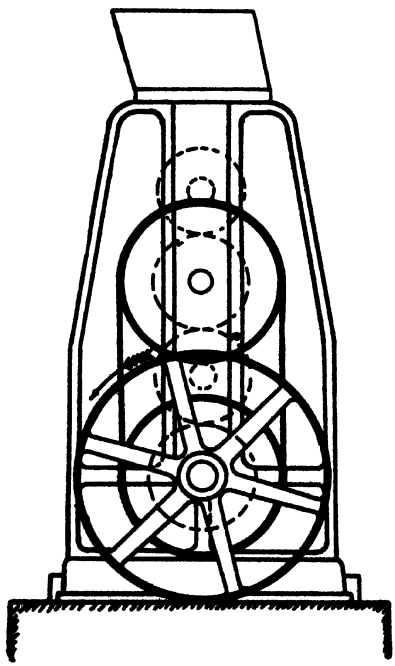


FIG. 85. Diagram Tandem Drive for Four-High Rolls.

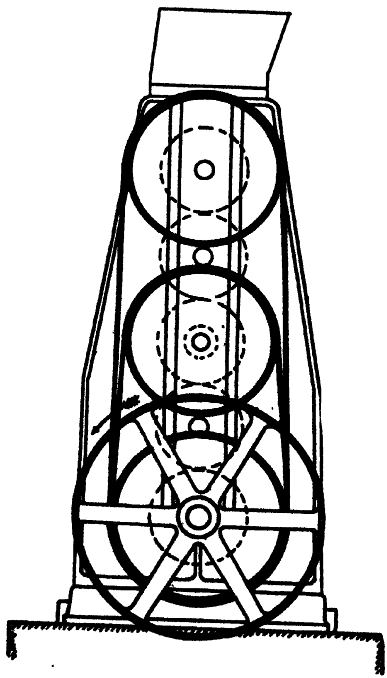


Fig. 86. Diagram Tandem Drive for Five-High Rolls.

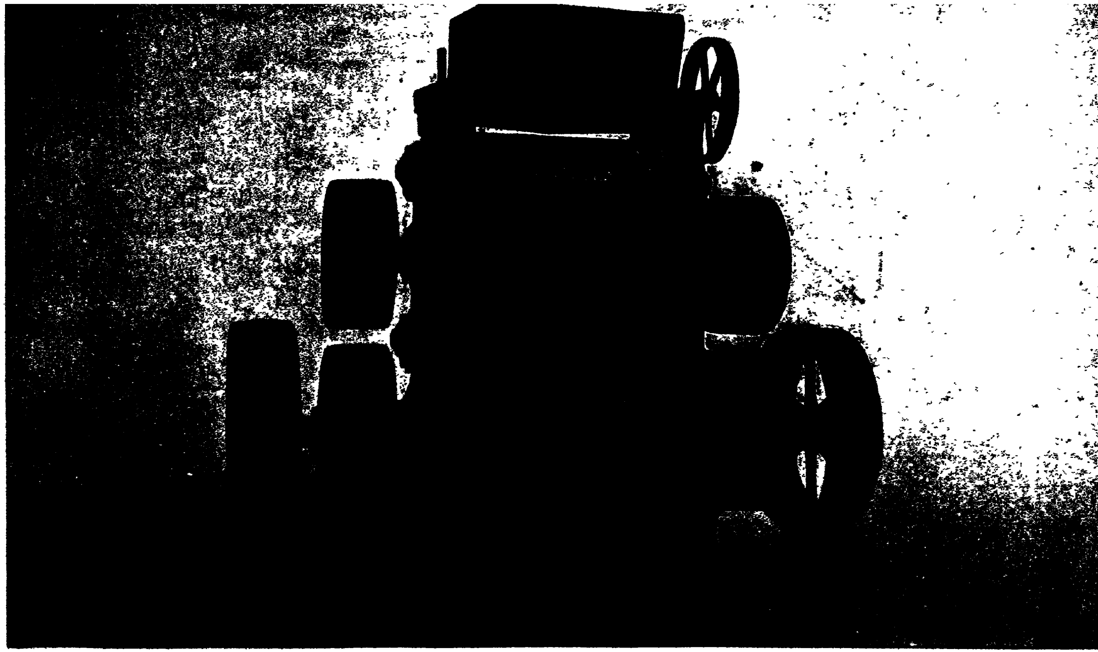


FIG. 87. Four-High Tandem Rolls.

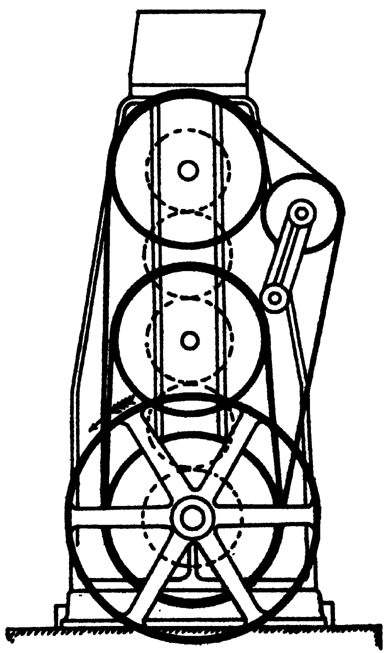


Fig. 88.

Diagram Tandem Drive with Tightener. Five-High Rolls.

by individual taste. The belt-driven rolls have the advantage of running with less noise, while the geared rolls give somewhat less trouble.

The capacity of these machines is governed by the number of rolls, and by their length. The smallest size has 4 rolls, 24 inches long, and is suitable for mills up to 30 tons capacity. The largest size has 5 rolls, 60 inches long, and is suitable for mills 80 to 150 tons capacity.

The speed of rolls should be 180 revolutions per minute. This may be varied 15 per cent. either way.

Heaters.

From the rolls, the crushed meats are taken to the heater, where they are cooked, preparatory to being pressed. This is one of the most important operations in the mill, and one requiring the most care and personal judgment. The objects of cooking are (1) to coagulate the albumen, so that it will remain with the solid matter in the press and not pass off with the oil; (2) to make limpid the oil contained in the meats, so it will more readily flow; (3) to evaporate the excess of moisture. If the cooking process is not carried far enough, the above objects will not be accomplished, and the oil will be mucilaginous from the effects of the contained albumen; the yield will be reduced, and the excess water will cause the press cloths to break. If the process is carried too far, the oil cells become hardened, the yield of oil is reduced and its flavor is injured.

There is no general rule by which to determine how long the cooking process shall continue. It must be determined by judging of samples, as the cooking proceeds. The time required varies from 15 to 40 minutes, (usually about 20 minutes), according to style of heater used, amount of meats cooked at a time, amount of steam pressure, dryness of steam, and character of meats being cooked. In any particular mill, most of the above variables are known and can be kept reasonably constant, so that the only governing [illegible] to be considered from day to day, is the quality of

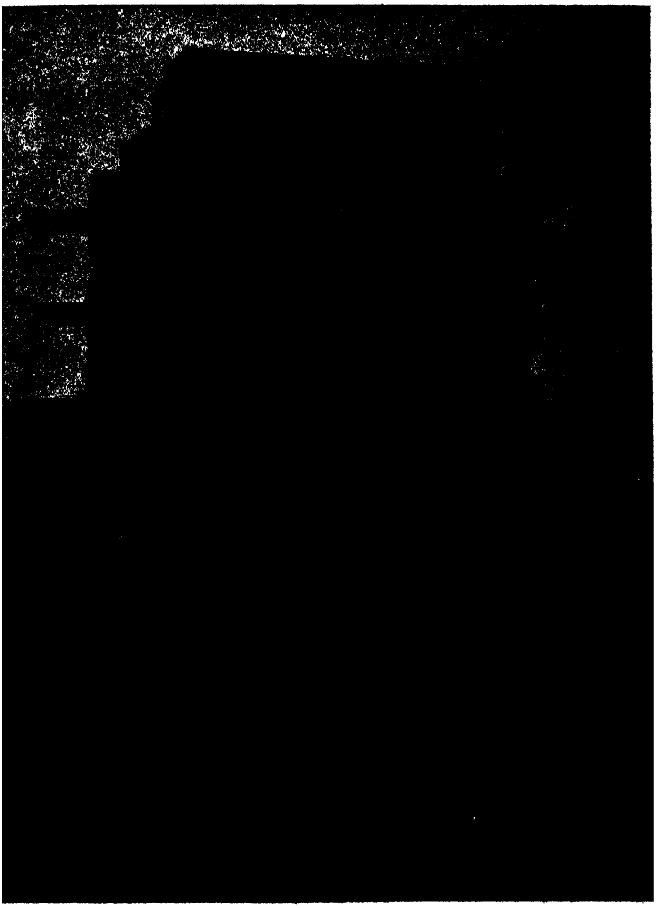


FIG. 89. Five-High Geared Rolls.

meats. This generally remains constant for several days at a time, and sometimes for several weeks, so that the clock may be relied upon as a general guide for cooking, but always supplemented by sampling, and by observing the actual yield of the oil from the presses.

The above relates to the use of uniform steam pressure and varying time of cooking, to suit different kinds of meats. Another plan, highly thought of by many good oil mill men, is to keep the time of cooking constant, and by adjusting the reducing valve, vary the steam pressure to suit different kinds of meats. This plan is more convenient and reliable, for the reason that the cook can usually readjust the valve for quicker or slower cooking better than he can read varying periods on the clock.

Another guide is temperature. It is found by experiment that the proper temperature to which the meats should be gradually raised, is 220 degrees F. Under most circumstances, a reliable dial thermometer, with end projecting into the air space, inside a heater, just above the meats, would indicate when the process is complete, but for some reason this method has never come into practical use.

The thermometer is a valuable adjunct to a heater, and should be observed as a check on other methods. A heater is always provided with a steam gauge connected to its heating jacket, and the attendant is careful to see that the pressure is always constant (50, 60, and sometimes 100 pounds per square inch), but this alone is no criterion for the temperature, because if the water of condensation is not kept constantly trapped out, the temperature will run down, while a high pressure is still indicated on the gauge. One of the most important things in cooking is to keep water of condensation trapped out of the steam space around the heaters.

The usual practice is to install two 52-inch heaters or one 72-inch heater for every two presses (say mill capacity 40 tons per day). The 52-inch heater cooks enough meats at

one charge for two presses, and with 50 pounds steam pressure, will on the average, complete a cooking in about 30 minutes. Thus two heaters will deliver eight pressfulls per hour, or serve the two presses four times per hour. The 72-inch heater cooks enough meats at one charge for three pressfulls, and with 50 pounds steam pressure, will, on the average, complete a cooking in 20 minutes, thus delivering nine pressfulls per hour. The heaters may be crowded beyond the capacity above mentioned by filling them fuller, (say 2½ pressfulls for the 52-inch heaters, and 3½ for the 72-inch heaters), and carrying a higher steam pressure. This practice always leads to inferior products (making oil too red and cake too hard) and should not be followed. Some experts even prefer to cook only one pressfull in a heater, and to use very low steam pressure, even down to 25 pounds. There seems to be no good reason for not cooking as much as two pressfulls at a time, but there is some virtue in the lower steam pressures. The only objection is that it requires longer time to cook, and hence, necessitates the installation of a larger number of heaters to do the same amount of work.

A mill with only one press would usually have one 52-inch heater. This would be at first charged with enough meats for two presses. When the cooking is complete, half the meats are drawn out to supply the press, and the heater refilled with one pressfull of raw meats. Treated in this way, the heater will turn out one pressfull every 15 to 20 minutes, and the cooking will go on continuously, instead of intermittently, as is the case when using more than one heater.

Figures 90 to 95 show various forms and arrangements of heaters.

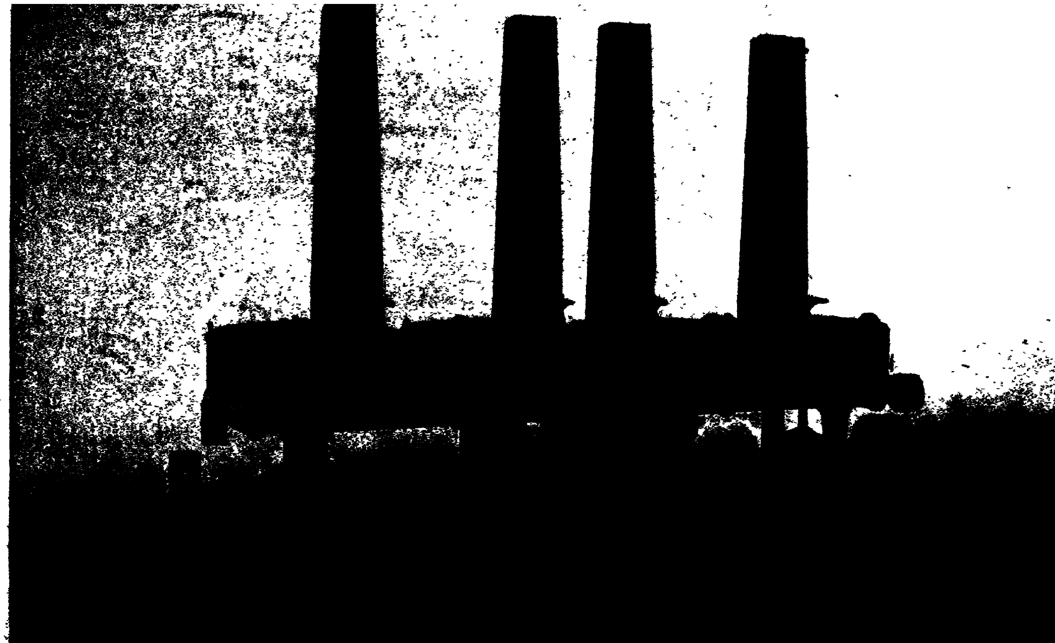


FIG. 90. Heaters with Gang Under Drive.

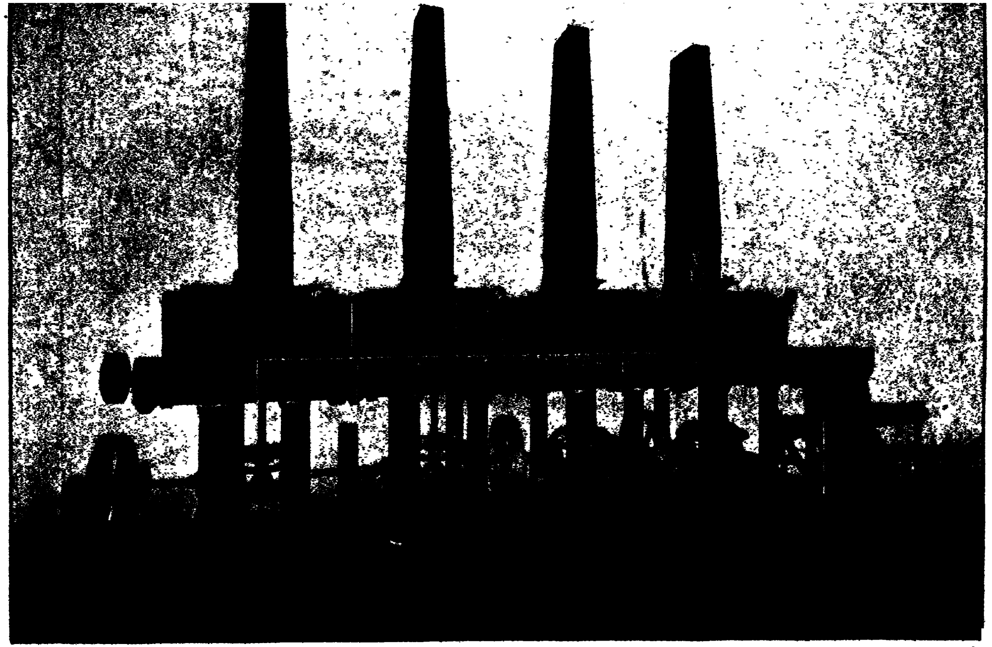


FIG. 91. Heaters with Independent Parallel Under Drive.

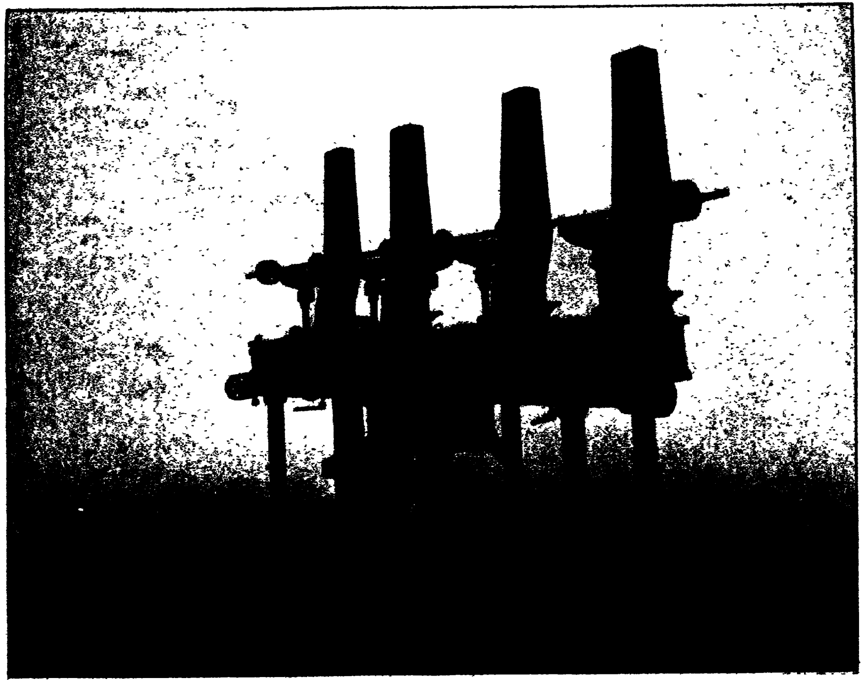


FIG. 92. Heaters with Overhead Drive.

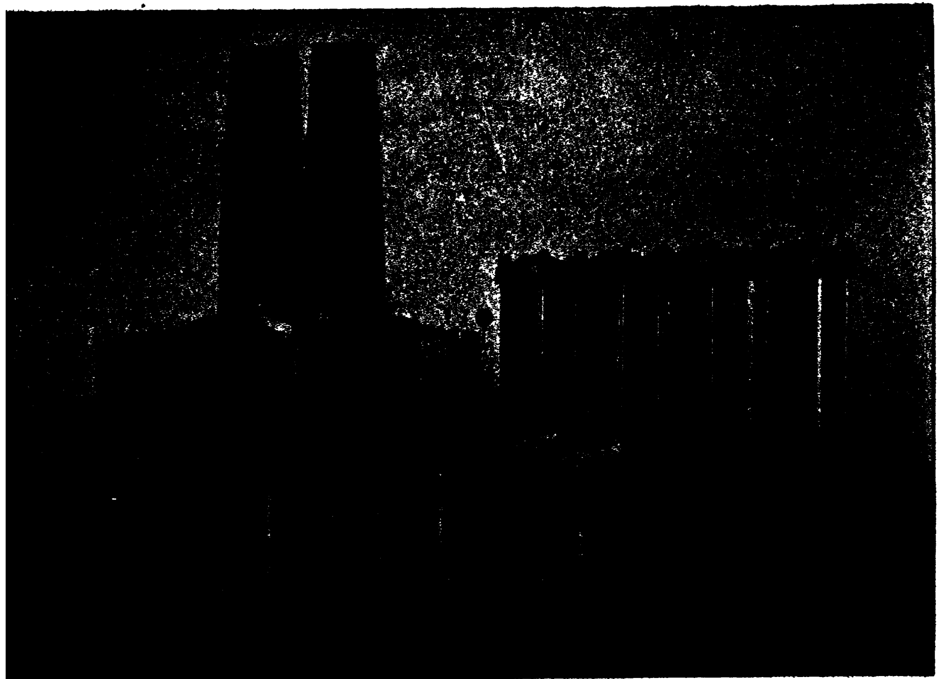


FIG. 93. Presses, Former and Heaters with Independent Right Angle Drive.

FIG. 94. Triple Heaters.

Triple Heater, Fig. 95—Lettering.

A.—Charging hoppers to hold a measured quantity of meats while waiting to be dumped into heaters.

B.—Cooking heaters.

C.—Conical head to carry stirrer arms.

D.—Stirrer arms.

E.—Space for steam to make the heat.

F.—Vertical stirrer shaft.

G.—Storage or sub-heater, to keep meats warm while waiting to be used.

H.—Horizontal driving shaft.

J.—Lid partly open to temper the cooking.

K.—Gate to dump charging hopper.

L.—Lever to operate charging gate.

M.—Former to make cakes for presses.

Process.

Charging spouts are filled with crushed meats by overhead conveyor.

Gate over one heater is opened, and the charge of meat quickly dumped into that heater.

After a few minutes, the other heater is similarly charged. When the first charge has become cooked, it is dumped into storage heater, from which it is drawn for use in the "former," which is the next machine in order.

First heater is again charged as before. In a few minutes more, the second heater has finished its cooking, and it is dumped into the storage heater.

Second heater is recharged, and the cycle of operations repeats itself, each heater being charged alternately, and timed to finish the successive cooking at equal intervals.

This process is actually intermittent, but is in effect, practically continuous, on account of the storage of the cooked meats in the lower heater, while being used.

This triple arrangement of heaters is not generally installed in smaller size than 72-inch. One set of 72-inch

triple heaters is about right for supplying 5 to 6 presses, or a mill capacity of 100 to 120 tons of seed per day.

Triple heaters are not so much in vogue as formerly. The arrangement shown in Figure 90 is almost universally adopted for the smaller size heaters, and in fact, now generally preferred for all sizes.

There are various methods of driving the stirrer shafts in heaters, as shown in the different engravings.

Figure 90 shows four heaters driven from a single underneath horizontal shaft, parallel with the line of heaters. Figure 91 shows the same general arrangement, except that each heater is independently driven. Figure 93 shows two heaters independently driven by underneath shafts at right angles to the line of the heaters.

Figure 92 shows a form of overhead driving. All of these various forms are in successful use, but the various underneath drives are the most popular. These are all self-contained, all the various shaft supports being provided for in the design of the heaters, while the overhead drives require supplementary supports, independent of the heaters. The particular form to be used in any given case must depend upon the conditions, and upon personal preference.

The speed of the stirrer shafts should be about 35 revolutions per minute. The bevel gearing is usually arranged so that the horizontal driving shaft runs three times as fast. Thus the shaft to which the belt is applied should run about 105 revolutions.

Former.

When the meats have been cooked, it is necessary to form them into cakes which may be put into the hydraulic press. The machine for making these cakes is called the former.

Figure 96 shows a direct-acting steam former, with steam carriage.

The carriage brings a measured quantity of cooked meats from the heater and deposits them on a press cloth spread in the gap shown. Steam is admitted under the

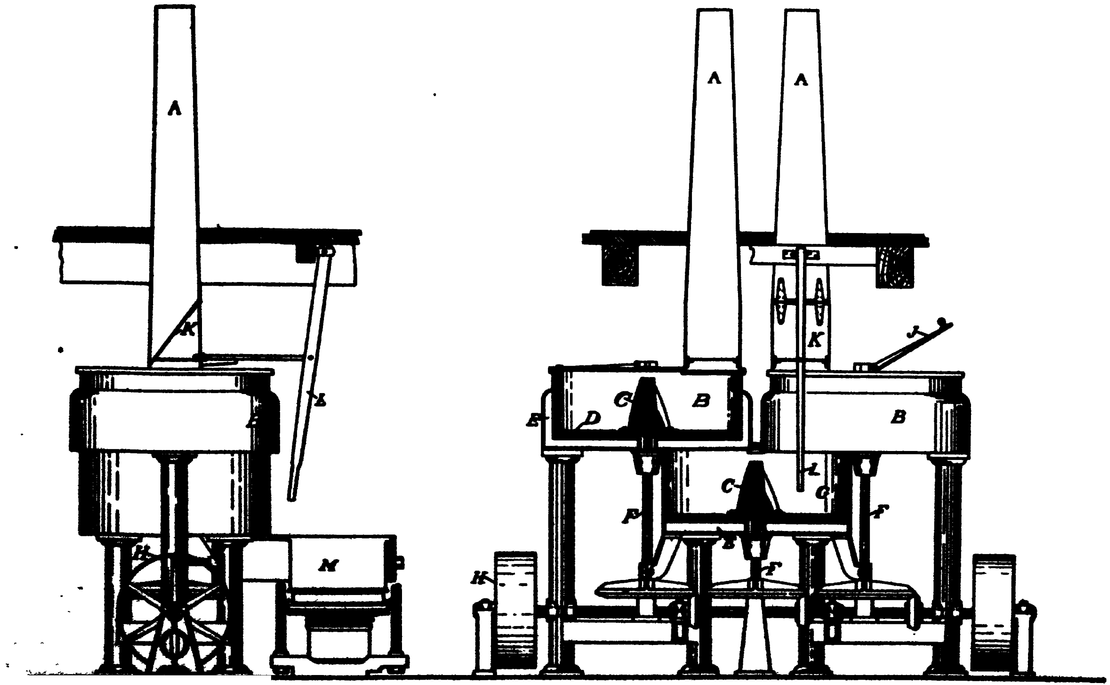


Fig. 95. Section Through Triple Heaters.

ram, and forces it up, thus pressing the cake against the upper frame. Steam is discharged, and the ram drops back into position shown. The two ends of the press cloth are folded over cake. Cake is removed on a sheet iron pan, and inserted in the press. The method of removing the cakes is shown in Figure 97. The various ways in which the former is arranged for receiving the meats from the heaters are shown in Figures 90 to 94.

Formers are sometimes made without the steam carriage attachment, in which case the operative pulls out by hand the carriage, which delivers the measured quantity of meats from the heater. The former shown in Figure 94 has hand carriage.

Sometimes the former ram is operated by compressed air, instead of steam. This has the advantage of being cooler and more agreeable to the operatives, and it avoids the unpleasant caking and cooking of the scattered particles of meats, which chance to spill out and fall on the cylinders.

Sometimes the former is operated from a hydraulic pump and accumulator.

Sometimes, though rarely, the former is operated by belt power. This is called a power former. This has gone out of use, except for the smallest mills.

The direct acting steam former, first discussed, is the most in favor, though the plan of operation by compressed air, which is now new, may come into general use.

Press.

When the cakes have been formed, they are lifted on a steel pan and inserted by hand into the compartments or "boxes" of a hydraulic press, and subjected to a pressure of about 350 tons, for ten to twenty minutes. The time allowed for a press to stand under pressure and drip, depends upon the relative balance between the capacities of the heaters and the presses. The heater capacity is usually so proportioned that, when cooking four charges per hour, the rated capacity of the mill may be attained; the press

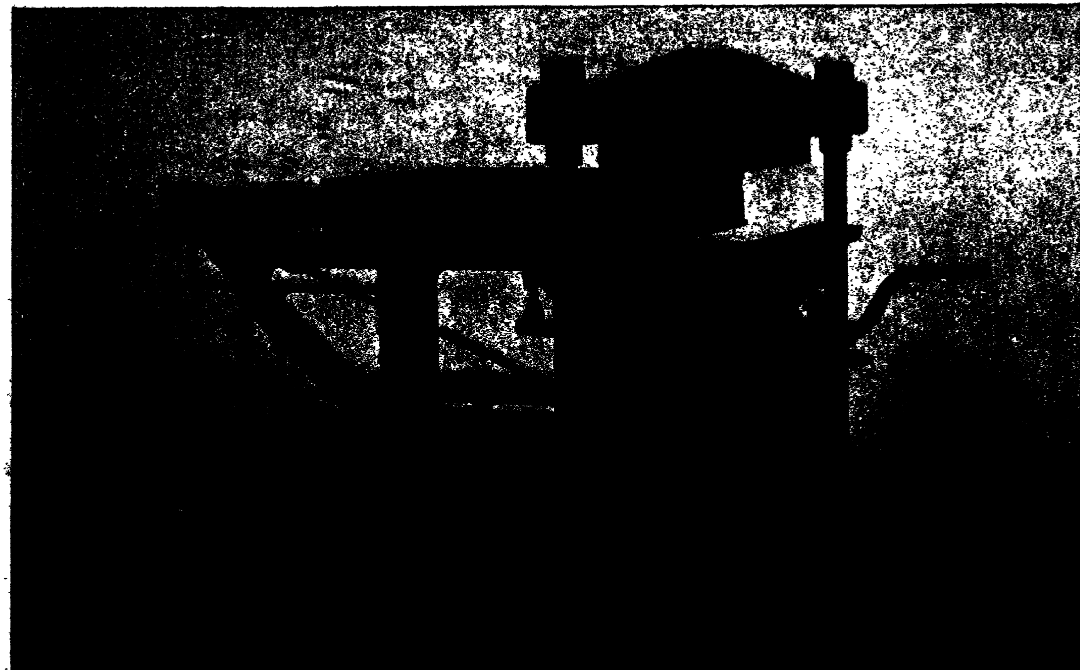


FIG. 96. Steam Cake Former.

FIG. 97. Interior of Oil Mill Press Room.

FIG. 98. Interior of Oil Mill Press Room.

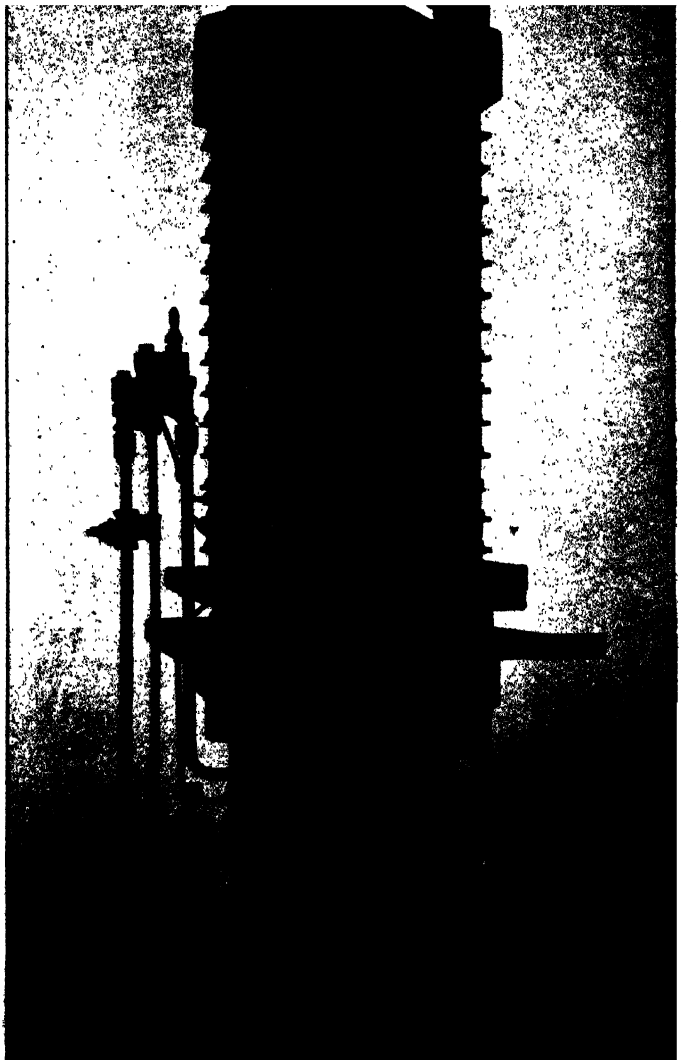


Fig. 99. Oil Press, Showing Valves.

capacity is arranged so that by making four pressings per hour, they will keep up with the heaters.

The yield of oil is to some extent increased the longer a press is allowed to stand under pressure; but if this is done to the extent of making the heaters wait, the capacity of the mill will be proportionately decreased.

Some mills install an excess of presses, so that they may be allowed extra time to drain. But careful judgment must be exercised, not to increase the cost of the mill to a point where the interest on the extra investment will not be repaid by the increase in yield of oil.

It will now be seen that the rapidity of the cooking and the pressing determines the capacity of the mill, and that this capacity will thus vary with character of the seed worked. One (15 box) pressing represents a capacity of about ¼ ton of seed, hence at four pressings per hour, each press will have a capacity of 24 tons of seed per day of 24 hours; at 3½ per hour, 21 tons; and at 3 per hour, 18 tons.

Figure 99 is a side view of the press, showing the valves by which it is controlled.

The hydraulic ram which applies the pressure is usually 16 inches diameter. The pressure applied to the ram by the hydraulic pump is about 3,500 pounds per square inch. This makes a total pressure of 700,000 pounds applied to the cakes. As the cakes are about 14 by 32 inches, or 448 square inches area, the pressure per square inch on the cakes is about 1,600 pounds.

Hydraulic Packing.

It is necessary to have a special packing to make the joint between the ram and the cylinder. Figure 101 shows the cylinder in section. The packing is shown at A. It consists of a crimp made of sole leather, formed in a mould made for the purpose. Figure 102 shows one kind of crimp mould. The leather used should be hard and sound. It is better to have it planed to a uniform thickness. It is put into the mould when thoroughly wet, and kept until

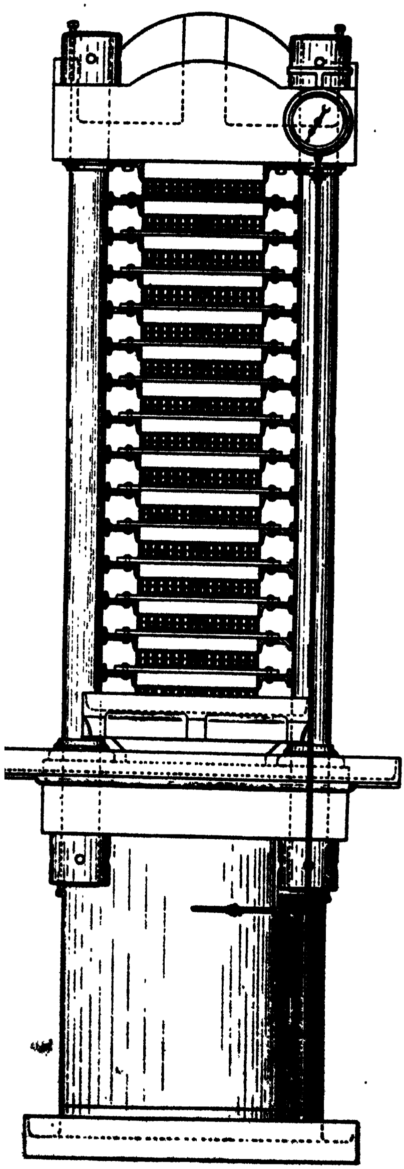


FIG. 100. Oil Press in Section.

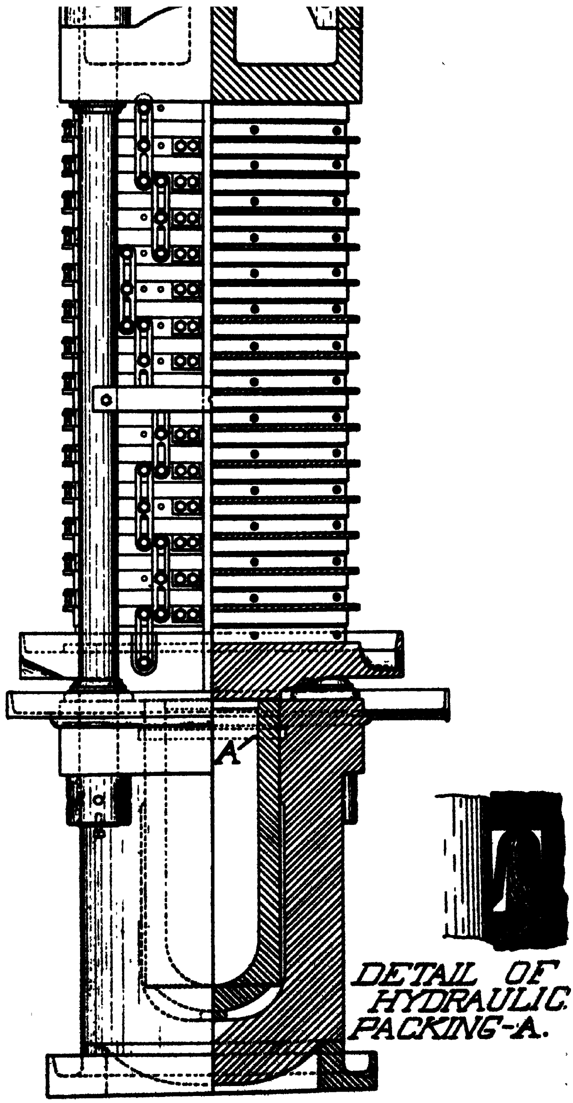


FIG. 101. Oil Press, Showing Hydraulic Packing.

entirely dry and hard. It is then taken out and the centre cut out, leaving a ring of the shape shown in Figure 101. It is carefully trimmed to the correct size and wedged into the recess with blocks of hard wood, such as walnut or maple. Care must be taken to so mould the leather that the hair or grain side of the leather will come next to the ram, where the wear comes. A good packing should last several months; but sometimes, on account of unseen defects in the leather, it may fail in a single day. A mill should always keep on hand one or more packings, ready for emergencies.

The blocks for wedging in the packing should be carefully formed to exactly fill the space in the leather cup and hold it firmly in place. A good way to make the blocks is to build up a wood cylinder of straight staves, after the fashion of a barrel, 12 or 15 inches long. The staves are glued together and fastened endwise to the face plate of a lathe and turned inside and outside to the proper diameter. The end of cylinder is turned to the proper shape and a ring of the blocks cut off. These are then split apart, and are ready for use. Several sets may thus be made and cut off and kept for future use.

Hydraulic Pump.

The pressure is applied to the presses by means of a hydraulic pump. Figure 103 shows the most common form. It is actuated by a steam cylinder, shown on the left. The spiral spring seen in the centre, serves to regulate the pressure, and the spiral spring at the right is the safety valve.

This pump is usually about 8x1x10 (steam cylinder 8 inches diameter, hydraulic plunger 1 inch diameter, with 10 inches stroke). Thus it multiplies the steam pressure 64 times, so that with 50 to 60 pounds steam pressure, on the pump, the hydraulic pressure is 3,200 to 3,840 pounds per square inch. The ratio between the two diameters is a very important matter; if it is too small there will not be sufficient pressure on the presses; if too large, by some accident

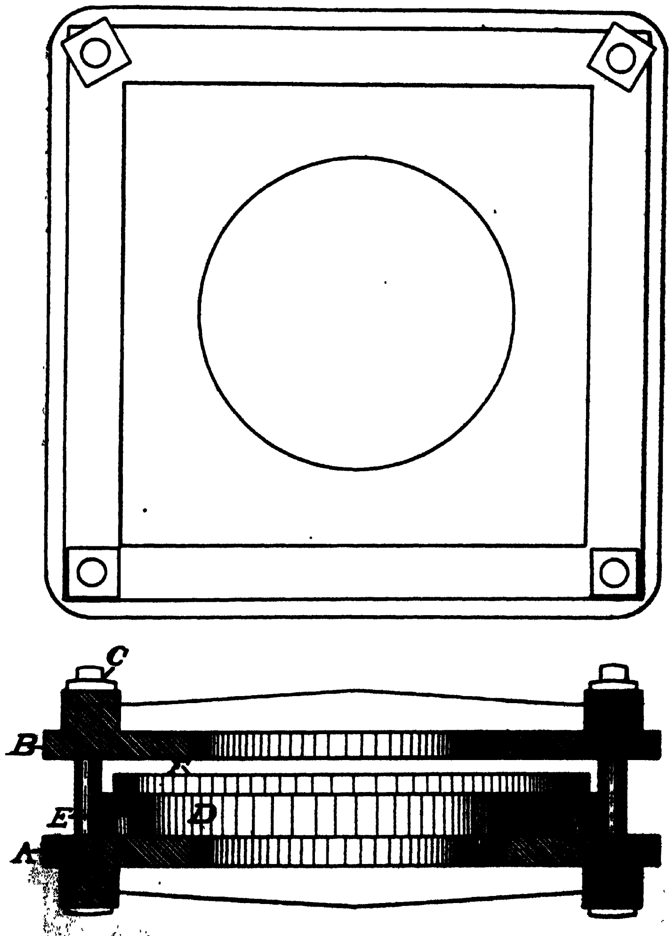


FIG. 102. Mold for Making Hydraulic Packing.

to the regulator, the pressure might become great enough to break the press.

The fluid used by the hydraulic pump, may be water, but the universal practice in oil mills is to use cotton seed oil. A small tank of oil is placed near the pump, from which it takes the suction. When the press runs down, the hydraulic oil is expelled from the pipes and discharged into this tank, where it is used over and over. It is important that this oil be clean and free from grit and all sediment, otherwise it will clog or cut the valves.

When crude oil is used for this purpose, the continued pressings seem to thicken it, so that the tanks must occasionally be cleaned out. It is a good plan to connect the hydraulic pump suction so that it will take oil about six inches above the bottom of the supply tank, so that the settlings are not so apt to get into the system. Where possible, it is the best plan to use refined oil for the purpose. This is not usually practicable in mills that do not refine their own oil, for the reason that on account of the various leakages, the tank must be frequently replenished. The system is so arranged that the leakages go in with the oil that is being produced, so that there is no final loss, except such loss as there is in refining.

When there are more than two presses, another pump is sometimes installed, for the purpose of taking up the slack in the presses, and putting up the pressure to about 300 pounds per square inch, at which point the high pressure pump is switched on, either automatically or by hand. The low pressure pump is about 10x2½x10.

There are several forms of hydraulic pumps that are driven by belts instead of direct steam, as above described. They require less power, but are not so convenient to operate as the steam pumps. Nearly all modern oil mills use steam pumps.

Accumulator.

When there are four or more presses, an accumulator is sometimes used for the purpose of giving out quick pressure, and for equalizing the work on the pumps, allowing them to run practically all the time, whether presses are going up or not. There are two kinds of accumulators, "pneumatic" and "dead weight." The pneumatic accumulator consists of a heavy piece of pipe about 12 inches in diameter and 6 feet high, so arranged that the pump will force oil into it and compress the air in its upper part, while the presses are not going up; when presses are ready, the compressed air will supply the pressure quickly and easily. The dead weight accumulator (two of which are shown in Fig. 104), consists of a weighted hydraulic plunger, which stores the pressure while presses are not needing it, and gives it out when required.

Accumulators are mostly in use in connection with the low pressure pump, (capable of making about 300 pounds per square inch); but they are also used in connection with the high pressure system, (3,000 to 4,000 pounds per square inch), where there are six or more presses. Fig. 104 shows a dead weight high pressure and low pressure accumulator, set up in the same frame. The high and low pressure pumps, used in connection with them are also shown. The low pressure accumulator is sometimes used to operate the "former," instead of direct steam pressure, but this is not the usual practice.

With a modern system of pumps and piping, the accumulator is of no practical use. It was originally designed to put the presses up quick. With a free opening, it does it too quickly, giving the material in the press a hydraulic blow, destroying the press cloth. To prevent this, a choke-valve was inserted in the pressure pipe. It is plain that there is no use to force reserve oil under pressure into an accumulator, and then choke down the flow to a rate less than the capacity of the pump.

Fig. 103. Hydraulic Steam Pump.

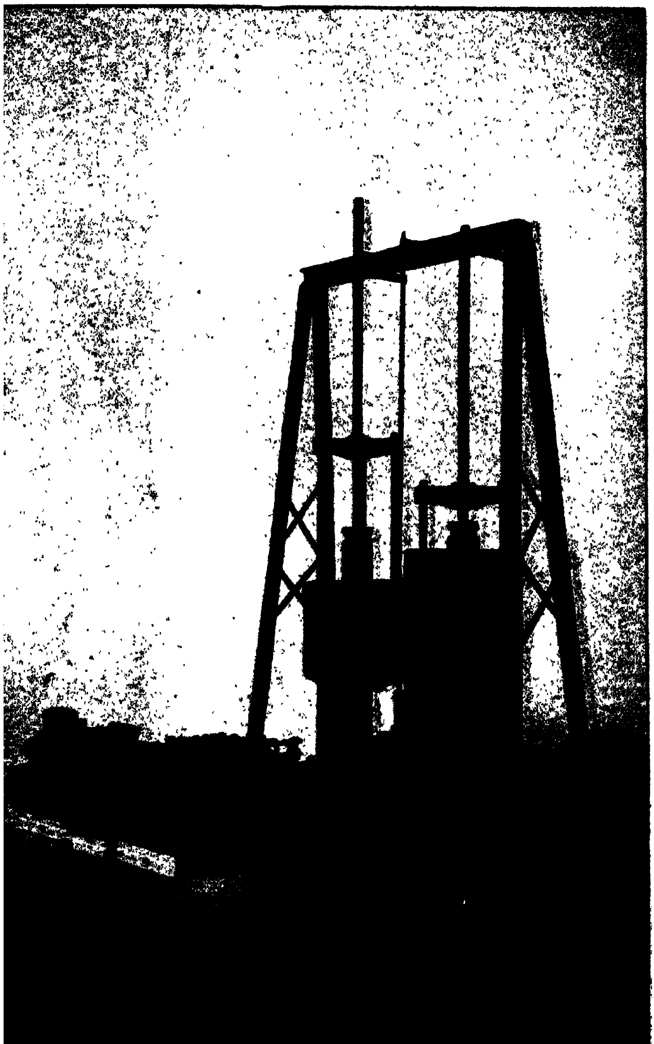


FIG. 104. Hydraulic Accumulators.

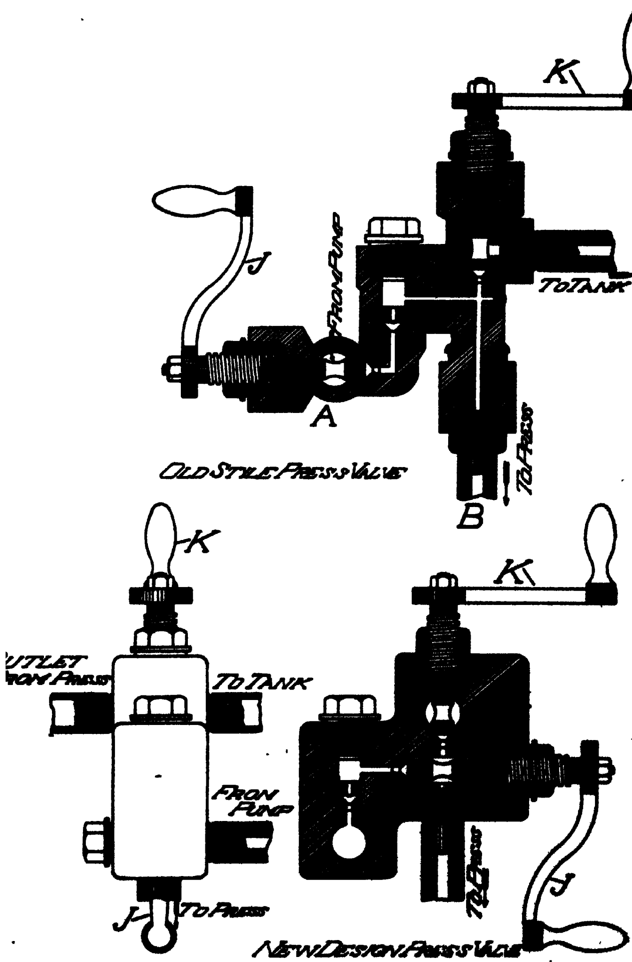


FIG. 105. Hydraülic Press Valves.

Press Valves.

The oil, under pressure from the hydraulic pumps or accumulators, is admitted to the press cylinder, and again discharged therefrom, when required, through a valve, generally known as the "change valve." Fig. 105 shows two forms of these valves. When pressure is to be applied to press, valve J is opened and K closed; when press is to be let down, valve J is closed, and K opened.

Formerly oil mills used power pumps with two different size plungers. See Fig. 109. One set of plungers put up 400 pounds pressure and the others 3,000 pounds pressure. The discharges were connected together to a pipe leading to a press. The low pressure was to put the ram up quick. Both plungers pumped into the same pipe. When the pressure reached the maximum of the low pressure plunger, a check valve between the two discharges was forced shut and the low pressure plunger discharged its oil out of a low pressure safety valve. When the high pressure (3,000 pounds) was reached, these plungers discharged oil back into the tank through high pressure safety valves.

On these power pumps, there were two low pressure plungers used for four presses, and four high pressure plungers—one for each press.

When direct acting steam pumps were introduced, one pressure only (3,000 pounds) was provided for. It was thought the steam pump could be regulated in speed and pressure to fill all requirements.

Afterwards it was thought best to have a low pressure pump in order to work the presses faster.

Automatic Change Valve.

In connection with this system of high and low pressures, with or without the accumulators, there was devised a system of automatic change valves to admit to the press the low pressure and automatically change over to the high pressure.

Sometimes the automatic valves were left out, and the changes made with the regular press valve, by a man watching the guage.

Fig. 106 shows an automatic change valve in section, connected by piping to a regular press valve shown above. The connecting pipe is shown broken to indicate that the automatic valve may be placed in any desired position with reference to the press valve.

Low pressure pump is connected to the press valve at A. High pressure pump is connected to the automatic valve at G.

To put pressure on press, close K, open J.

Pressure is admitted from low pressure pump through A and adjacent check valve, through B and onward.

At 300 pounds pressure, plunger D is pressed down strongly enough to open E.

This admits high pressure through E, F, H, and onward.

High pressure shuts low pressure check valve and holds D down.

At H is a choke valve to admit the high pressure very gradually. This is to save press cloth and give the oil time to flow out of the meats in the press.

Valves similar to this are still in use, but some late valves are very much simplified in design.

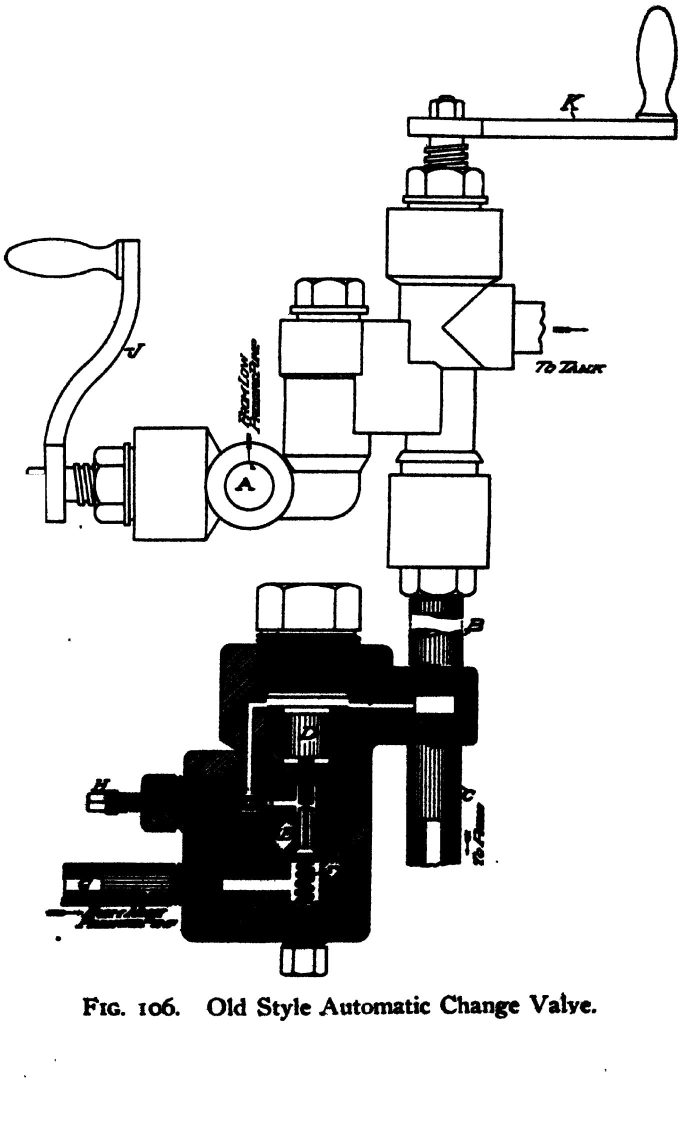


Fig. 106. Old Style Automatic Change Valve.

Improved Automatic Change Valve, Fig. 107—Lettering.

Fig. 107 shows a cross section of an improved change valve, having fewer parts than any of the old forms. Both high and low pressure pumps are connected to this valve.

A.—Pipe from low pressure pump.
B.—Check over same.
C.—Port to press pipe.
D.—Pipe to press.
E.—Pipe from high pressure pump.
F.—Choke valve.
G.—Stop valve, high pressure.
H.—Stop valve, low pressure.
J.—Crimp packing.
K.—Leather gasket.

When valve at press is first opened, low pressure flows through pipe A and check B, to press.

At the same time, the high pressure pump forces oil through the slot in choke valve F. (This slot is a mere notch filed across face of valve.)

As oil passes through this choke valve its pressure becomes as low as the pressure from low pressure pump. Thus both pumps contribute to hasten the ram, and when the slack of the press is taken up, the high pressure pump, continuing to put oil through the choke valve F, gradually raises the pressure to above that of the low pressure pump. Then the check B closes, and the pressure continues to rise by the action of the high pressure pump alone. The choke valve makes this rise of pressure very gradual, and it is this regulation of the rise which saves the press cloth and makes a greater yield of oil from the presses.

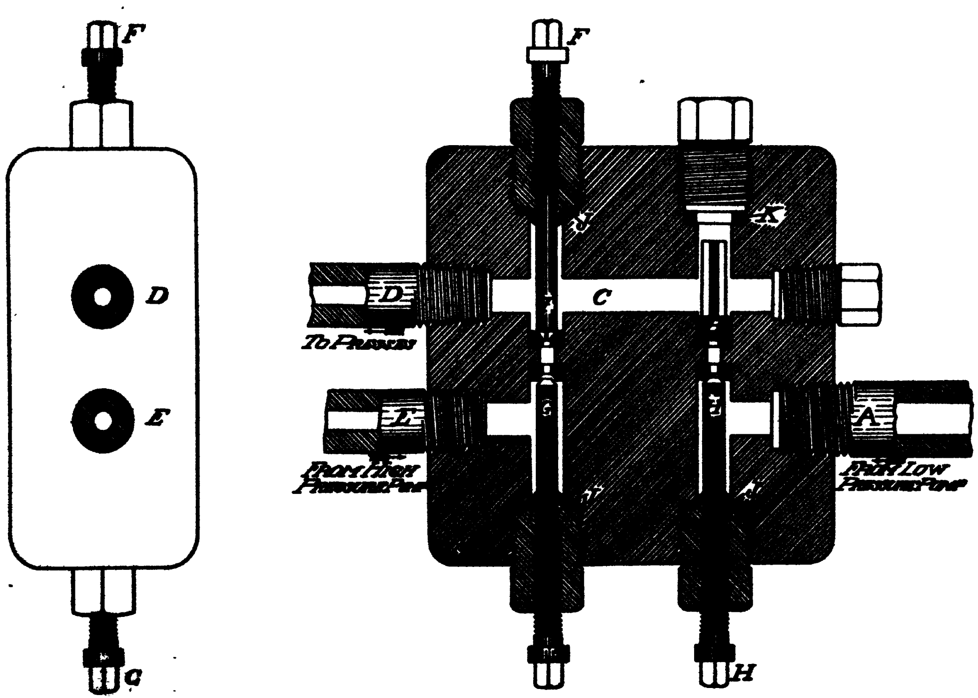


FIG. 107. New Style Automatic Change Valve.

Fig. 108 shows a high and low pressure pump, piped up to three presses. More presses could be added if desired.

A.—Low pressure pump.
B.—High pressure pump.
C.—Automatic change valve.
D.—Side view of automatic change valve.
E. H.—Press change valves.
F.—Pipe to press.
G.—Presses.
K.—Discharge pipe to tank.

The automatic change valve C (see Fig. 107), is put near pumps. By this plan, only one line of pipes is required, to go from the automatic change valve to as many presses as one set of pumps will supply.

Old Style Press.

The foregoing system of pressing is of recent origin, having been first introduced in 1882. Previous to that time, and for several years thereafter, the cooked meats were put by hand into small bags, and folded up into hair mats, and put into the press boxes. This hair mat resembled a large, long book, opening at one end. This mat, with the bag of meats folded within, was about 5 inches thick, so that the press boxes had to be about 6 inches deep. Thus, a press could only hold five or six boxes, to keep the top box within reach of a man standing on the floor. The capacity of these presses was about one ton per box per day. The pressure required to press five or six cakes is as much as for twelve or fifteen, so that a mill had to provide much more machinery to get a given capacity than by the present system.

The former was invented to make a preliminary pressing of the cooked meats, so they would not occupy so much room in the press. The cake delivered by the former is only about 1½ inches thick. These are wrapped in cloth, put directly into the press boxes, without the use of any

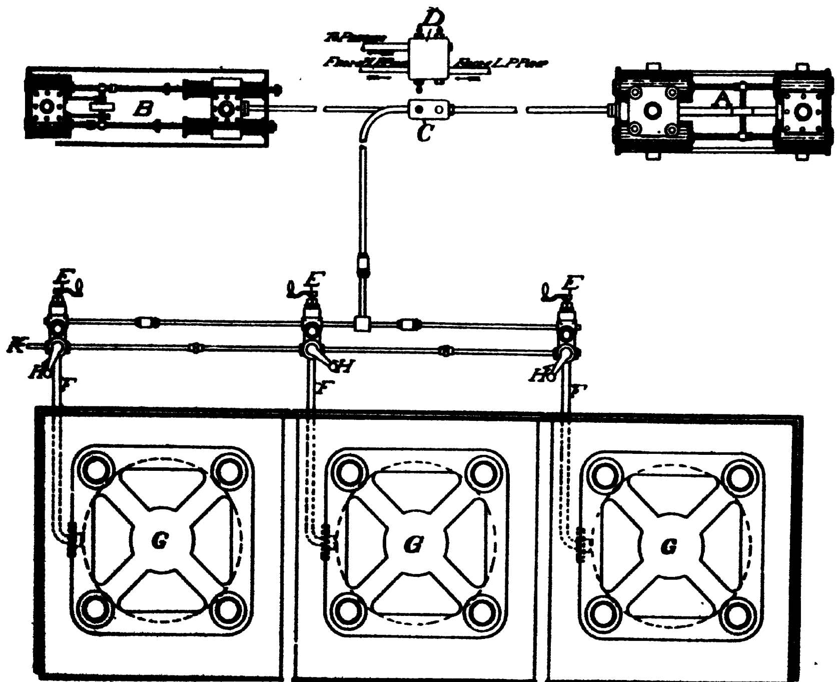


FIG. 108. Pump and Press Connections.

mats, so that by this system about fifteen boxes may be arranged in a press of the same height as the old one. The old system was rapidly abandoned, so that by 1890, not 5 per cent. of the mills were using it. At the present time, there are a very few mills operating under the old system.

Press Cloth.

A large item of expense in the operation of an oil mill is the camels' hair press cloth. This expense may easily be made three or four times as great as it should be, if all the conditions are not just right. Proper cooking of the meats is the first consideration for the preservation of press cloth, (as well as for the quantity and quality of the oil).

If the moisture and sap is not sufficiently cooked out of the meats, the press cloth will be badly broken. The speed of the presses is another factor. There is no objection to the rapid working of the press up to the point of about 500 pounds pressure per square inch on the ram, which is about the point when oil begins to flow freely. When the pressure passes this point, the increase of pressure and the movement of presses must be slow enough to let the oil escape through the press cloth without rupturing it.

When high pressure (3,500 pounds), alone is used, great care must be taken not to put the pressure on too rapidly. The limit as to maximum pressure is controlled by an automatic regulating valve on the pump, and to prevent putting the high pressure on too quickly the steam throttle in the supply pipe is so arranged as to admit steam very gradually behind the piston.

This works fairly well with one to two presses, and if carefully looked after. For more than two presses, it is important to have two pressure pumps, one high pressure (3,500 pounds), and one low pressure (300 pounds), connected with each of the presses, through an additional change valve, as previously described.

It is not impossible to carry to excess the effort to save

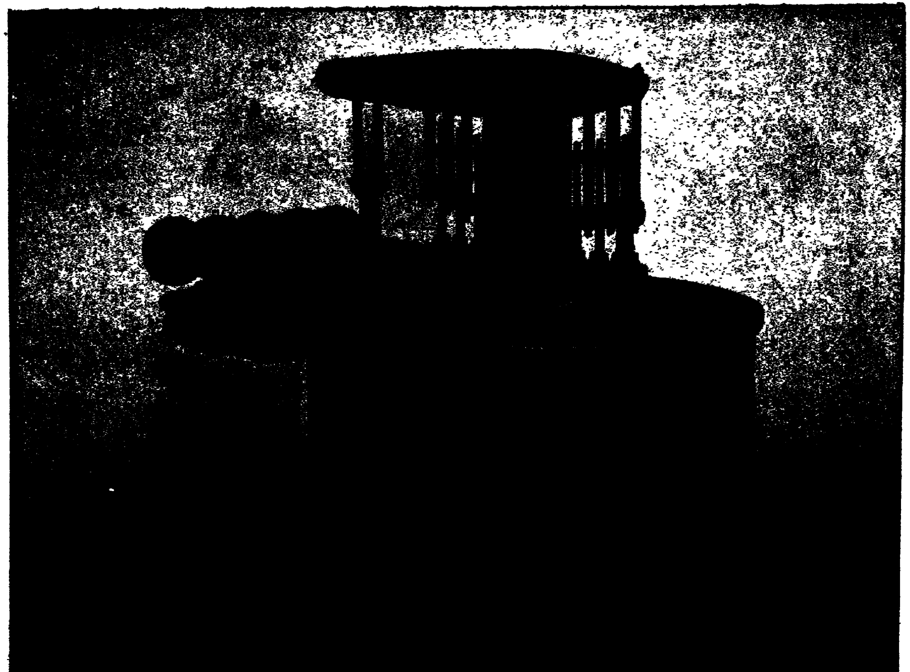


FIG. 109. Hydraulic Power Pump.

press cloth (without regard to other matters). For example, the heaters or presses might be run on so slow a schedule, in the effort to save press cloth, that the loss of capacity of the mill would more than overbalance the saving. Judgment must be used in finding the proper balance between straining the capacity of the mill, at the expense of the press cloth, and keeping down the capacity for the purpose of saving it.

When the pressure is released on the presses and they run down, the cakes remaining in the boxes are loosened up by a man behind the press with a short flat bar. The man in front takes out the cakes and piles them on the stripping table where another man strips off the press cloths and passes them back to be used again. If the meats have been sufficiently cooked, the cloths strip easily, and without damage. One cloth weighs about three pounds, and costs about $1.50. With good usage, it should stand 600 to 700 pressings. The cost per ton of seed is 12 to 20 cents. Press cloths are mended on a stout sewing machine designed for the purpose.

Disposition of Oil.

As the oil flows from the presses it is caught in a shallow trough behind. This trough also incidentally catches a lot of meats and broken cake that fall around the presses. In order to entrap these in the trough and allow only the clear oil to run off, the oil outlet enters the trough near the top. The oil runs off into a tank under the floor. Sometimes there is still another tank under the floor, into which the oil from the first tank runs out from a pipe near the top with the idea of leaving the sediment in the first tank. The oil is pumped out of the second tank to the storage tanks, located wherever convenient on the premises. All the above precautions still do not entirely free the oil from sediment, so that there will be much sediment found in the storage tanks. This sediment contains some water, and in warm weather, it will tend to sour and damage the oil. Hence it is not a

good plan to allow crude oil to stand long, in summer, unless it is pumped off into clean tanks, after standing awhile.

If tanks are cleaned out often, before the settlings sour, the settlings may be mixed with the cooked meats and pressed again, so that if carefully attended to, there need not be much waste from settlings.

Filtering crude oil through a special filter press is coming into limited use. This makes a nice, clear oil, which is somewhat more salable than unfiltered oil. But the process is a difficult one; the filter becomes so quickly clogged. Some form of gravity filter is the easiest to operate. Such a filter may be easily made by loosely filling a tank with straw, over a false perforated bottom. Where the oil mill has a refinery, the question of filtering is not of so much importance, because the sediment is precipitated in any case, when being refined.

Cake Cracker.

When the cakes leave the presses, they weigh twelve to fourteen pounds. They are stacked up to air-dry, for twelve to twenty-four hours. Sometimes the cakes are put in racks to dry. They are then put by hand into the cake cracker, which grinds them into pieces about the size of a grain of corn, so that they may be fed to a mill for still finer grinding. This machine must be very strong and durable to crack the very hard cakes. Fig. 110 shows one very good form of cake cracker. The crusher rolls are revolved in different directions, at a speed of about 300 revolutions. This machine will handle about one ton of cakes per hour, and will thus be sufficient for an oil mill of 70 to 75 tons (of seed) per day.

Meal Mill.

The cracked cake is taken to the mill for fine grinding. This may be an ordinary corn or wheat mill, but is preferably a mill with chilled iron plates. Fig. 111 shows one form of iron plate mill, known as an "attrition mill."

FIG. 110. Cake Cracker.

FIG. 111. Attrition Meal Mill.

The plates revolve in opposite directions at a speed of about 1,500 revolutions per minute. The engraving shows the outer casing removed for the purpose of changing the grinding plates.

These mills are made in various sizes, from plates 20 inches to 36 inches in diameter. The capacity ranges respectively from one to four tons of meal per hour, being suitable for oil mills of 30 to 100 tons (of seed) per day. Most mills arrange to grind in 12 hours all the cake that is produced in 24 hours. The above rating is based on this practice.

The broken cake is fed to the mill at the top, and the fine meal is delivered under the bottom in the centre.

It is possible to grind fine marketable meal with these mills, if they are not crowded too near their ultimate capacity. The domestic demand for meal is not so critical about fineness as the export trade. It is usual in grinding meal for export trade by whatever process, to pass it through screens or bolting chests, to reduce it to a uniform grade, and free it from hulls and lint.

The attrition mill does its work largely by making the particles of cake grind each other. Therefore it is important that the mill have enough feed as well as not too much. An attrition mill, when underfed, will do its work as poorly as when overfed.

Some mills have their screening machinery so arranged that the material from the cake cracker is first screened for the recovery of such fine meal as may be possible, before carrying it to the grinding mill. This is an economical process, as it relieves the mill of some duty. The large lumps of cake thrown into the revolving screen have a tendency to break the perforated metal or wire cloth, and on account of the additional repairs thus entailed, the process has not become popular. The screens should be covered with perforations about 1-16 to 1-20 inch diameter. The screening is, however, generally all done after the grinding. In some cases, mills grinding for a very critical market have screened

as fine as 1-32 inch. The finer the screening, the more expensive the process, the more power and the more grinding mills required, because the coarse particles which will not pass through the perforations, have to be reground again and again until they will pass through.

For the domestic trade, some mills screen meal through 3-32 perforations, mostly for removing lint cotton which has escaped the linters, and which is attached to the particles of hull, still to be found in the meal. The finer the grinding the more digestible the meal is for stock food. The Germans lay great stress on this point.

Most oil mills sack and weigh the meal by hand; but lately some of the larger mills are installing weighing machines, with great success.

It is usual to install the cake-grinding machinery in the oil mill building, and to carry the meal to the meal storage house with a conveyor, and there sack and store it.

A mill should have its meal storage separate from the seed storage; otherwise if seed are stored where meal has been, the lint on the seed becomes discolored by the yellow meal, and deteriorated in value.

TABLE XV.

SHOWING AVERAGE SPEEDS, CAPACITIES AND POWER REQUIRED FOR VARIOUS MACHINES IN A COTTON SEED OIL MILL.

MACHINE	Speed	Capacity in Tons Seed in 24 Hours	Horse Power
Sand and Boll Screen . .	20	40	3
Linter	350	5	4
Linter	350	10	3
Huller	900	40	10
Huller	900	100	25
Separating Screen	20	40	3
Rolls	180	40	10
Rolls	180	100	30
Heater	105	40	8
Heater	105	100	20
		Capacity in Tons Product in 12 Hours	
Cake Cracker	300	25	5
Cake Cracker	300	65	12
Meal Mill	1800	25	25
Meal Mill	1200	65	50
Hull Press	400	40	5

For shafting, add 20 per cent. to power.
For conveyors and elevators, add 10 per cent. to power.

In some cases in the foregoing table, the machines are given two ratings in capacity and power. In the case of the linters and hullers, the variations may be made by varying the amount of material fed; in the case of the other machines, the variations are due to using different size machines for different capacities desired.

The capacities and corresponding power required, may be

widely varied according to the way in which the machinery is forced, and according to the general skill in operating the mill as a whole.

The usual allowance of power for various size oil mills is $2\frac{1}{2}$ horse power per ton (of seed) capacity per day of 24 hours.

CHAPTER XIII.

Cotton Seed Oil Refining.

Crude cotton oil, in common with most crude vegetable oils, is an intricate mixture of chemical compounds, containing more or less impurities in mechanical suspension or solution. The chemical compounds are made up of nearly neutral bodies formed by the combination of certain acids with certain other bodies having an affinity for the acids. The completeness of the chemical combination between these two classes of bodies constitute the principal element in the value of the oil. The chemical reactions in oils are so intricate that the easiest understanding of them may be obtained by analogy with more simple compounds, such as are formed among inorganic substances. For example, sulphate of zinc is formed by the action of sulphuric acid upon zinc. If sufficient zinc is supplied for the quantity of acid present, there will result a perfectly neutral compound, which will show no acid reaction whatever; if, however, the amount of zinc is deficient, the compound will contain "free acid," that is, acid which has not found anything with which to combine. It remains there ready to combine with anything for which it has an affinity, such as an alkali or a metal. If it is desired that the above compound shall be perfectly pure or neutral, the free acid must in some way be eliminated. If zinc is available the most obvious and economical way would be to add just enough zinc to neutralize the free acid, so that the compound would all be pure sulphate of zinc. But if zinc cannot be obtained, some other metal or alkali may be used to neutralize the free acid, provided such a substitute will produce a sulphate which can be separated by precipitation, or otherwise, from the sulphate of zinc desired.

Cotton oil is roughly analogous to sulphate of zinc, sulphuric acid being represented by a mixture of oleic, stearic and palmitic acids, and the metal by a vegetable substance

called glycerol. The above mentioned acids belong to a series known as "fatty acids." Upon the complete balancing of the fatty acids with the glycerol, depends the neutrality, and generally speaking, the commercial value of the oil. Fresh crude oil, made from sound seed, will contain fatty acids in excess of the neutral requirement to the extent of ½ to 1 per cent. of the total weight. The chemical affinity between elements in cotton oil is very much weaker than in inorganic substances, and as crude oil grows older, more and more acid becomes dis-associated or "free." Likewise, when seed become heated, more acid in the contained oil becomes free. This setting free of fatty acids is one of the causes producing what is known as rancidity in oils.

Cotton oil is frequently alluded to as containing 1 to 2 per cent. of fatty acid, when "free" fatty acid is meant, the entire amount of combined fatty acids in any cotton oil being about 70 per cent. The total contents of fatty acids in oil may be determined by completely saponifying the oil and treating the soap with weak sulphuric acid. Sulphuric acid has a greater affinity for glycerol than the fatty acids, and it displaces them and sets them all free, so they can be separated and weighed. Fatty acids do not present any of the ordinary features popularly ascribed to acids. Most of them are at ordinary temperatures solid, and they are not sour to the taste, and they do not indicate with litmus paper, as do inorganic acids. In chemical tests for fatty acids, the indicator used is phenolphthalein, a yellow powder dissolved in alcohol. To determine the amount of free fatty acid in any given oil, measure a certain quantity of oil, add a few drops of the indicator and slowly add measured quantities of an alkali of known strength, violently shaking after each addition, until the indicator turns the whole solution a light pink. This shows that the acids have just been neutralized, and the percentage may be calculated from the amount of alkali used. These fatty acids have been mentioned in conjunction because they are chemically quite similar, and all the reactions are about the same. The quantities are usually

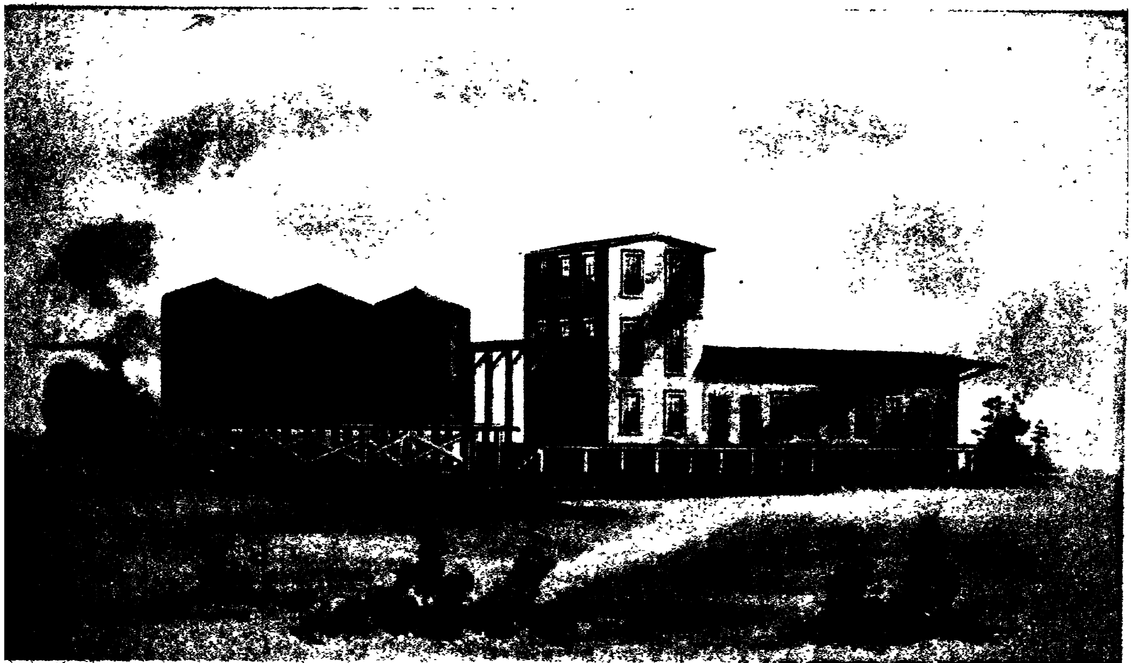


FIG. 112. General View of Cotton Oil Refinery.

chemically computed as so much oleic acid. Some of their physical characteristics are different, as for instance, melting points and specific gravities. Oleic, stearic and palmitic acids when in combination, as in cotton oil, make compounds known respectively as olein, stearin and palmitin, which partake of the characteristics of their respective acids. The first two are the principal constituents of cotton oil. Olein remains liquid at a lower temperature, and is lighter than stearin; hence, as the temperature is lowered, stearin begins to solidify and settle. This is the basis on which their separation is in practice accomplished, as in the manufacture of winter oils.

Crude cotton oil contains, besides free fatty acids, other impurities, such as water, cotton seed meal, mucilaginous matter, and a brown coloring matter, which latter appears to be inherent in the seed, and to occur in solution in the oil. Excepting the free acids and the coloring matter, these impurities may be removed by filtration or by settling; or they may be mostly prevented by care in manufacture.

Water and mucilaginous matter (mostly albumen) occur naturally in cotton seed, and should be separated from the oil in process of manufacture. In these processes the water is mostly evaporated, while albumen is coagulated and together with the remaining water, is supposed to be left in the residue or cake, when the oil is pressed out. Carelessness in manufacture, or an effort to obtain the last bit of oil in the seed, or to rush the process through in the shortest time, will result in throwing these impurities into the oil. One of the methods for quickening the time in manufacture, is cooking with high pressure steam. It is necessary to heat the kernels to about 220 degrees Fahrenheit. This may be accomplished by cooking for a long time with steam at 50 pounds pressure (298 degrees F.), or for a short time with steam at 100 pounds (338 degrees F.). The former produces the best oil; the latter is the cheapest process. The same applies to the degree of hydraulic pressure in the presses. Even the coloring matter in the oil is lessened by lower pressure in both cases.

In the development of modern crude oil mills, high pressure and quick processes having, from their commercial superiority, become most common, it is required of the refiner to accept crude oil as it comes, and make the best refined product. The first requisite is to remove by filtration all the foreign matter in suspension, and, if the oil is to stand for any length of time before refining, remove, by settling and drawing off, any water that it may contain. If crude oil stands for several months without this preliminary attention, the water and particles of meal and gum will sour in the bottom of the tank, and foul gases will rise through the body of the oil, and be partially absorbed. But if the oil is to be refined immediately after it is made, these impurities may be removed in the course of refining.

Refining consists in removing free fatty acids, brown coloring matter and any other foreign matter that may exist in crude oil. This gives the product commonly referred to as "summer yellow oil." It should be a light straw color, free from sediment or water, and entirely neutral, (that is, free from either acid or alkali), and nearly tasteless. This condition is referred to in the trade generally as "prime," or, when with but the smallest possible taste, "butter oil." The trade definitions are not absolute, but depend upon the individual judgment of the sampler. Large sales should always be made by sample, rather than by definition. As most of the best cotton oil is finally intended for culinary use, it is best judged by tasting. Any oil that is the least offensive to a sensitive taste, no matter what its chemical purity, cannot pass as prime.

Caustic soda is the principal chemical used in refining. It is received at the refinery in iron drums, weighing about 700 pounds. The kind known as 74 per cent. is generally used. The purer it can be had, the better it refines. It is sold on a basis of 60 per cent. If it is 74 per cent., the actual cost is 14-60 more than the basis price. The soda is broken up and dissovled in an iron tank. Its solution generates considerable heat. Great care should be exercised in handling

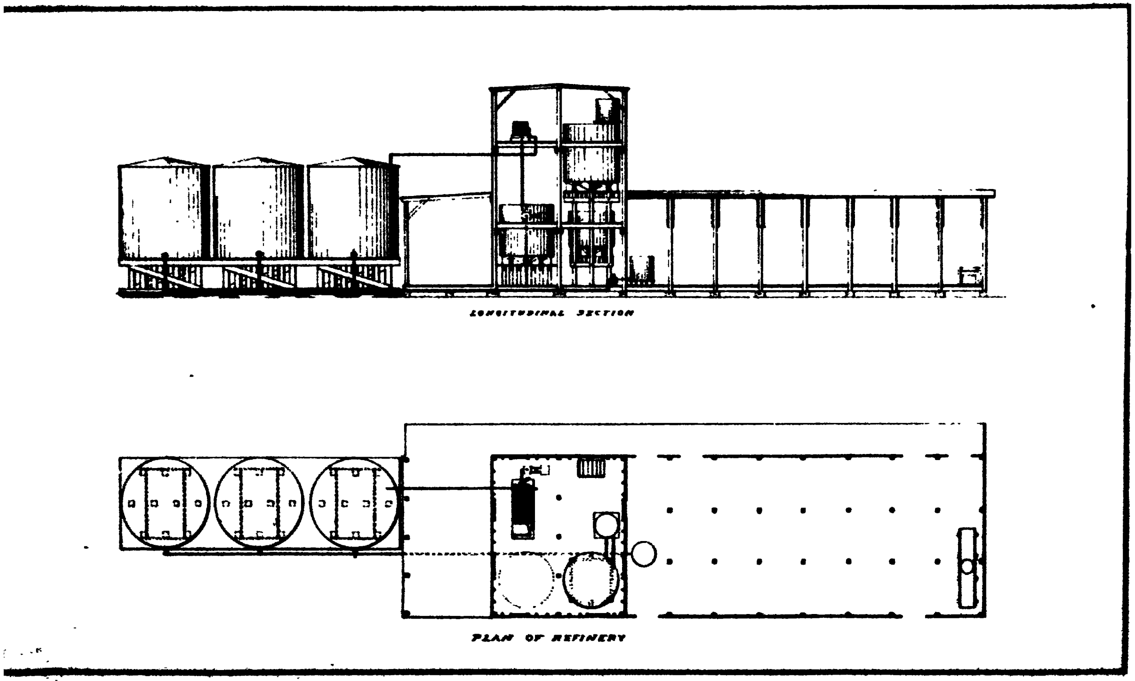


FIG. 113. Plan and Section Cotton Oil Refinery.

this substance, both while solid, and while in solution, as it is very dangerous. A small drop of the concentrated solution would make an angry burn on the flesh, or would put out an eye. The dissolving tank is usually located under the floor, so that it is not necessary to lift the heavy drum of soda to get it in the tank. When solution is perfect, it is pumped into the mixing tank located above the refining tank, where water is added to bring it to the required strength. Only the cleanest, purest water should be used, and the solution should be cool (not over 90 degrees) before used. The strength of the solution is measured with a hydrometer with Baume' scale. It is usual to have with the hydrometer, an iron or copper pot, holding about a gallon, and being deep enough to float the instrument. This is dipped full of the solution, and tested from time to time as the water is added. The desired strength and amount to be used must be separately determined for each different lot of crude oil. Theoretically, the amount of alkali required might be determined by finding the amount of free fatty acid present in any particular lot of crude oil under consideration, and calculating the amount of alkali necessary to neutralize it; but practically, this would not be sufficient for the purpose of refining, because it is found by experience that an excess is required for the purpose of saponifying a small quantity of the oil after the free acid is neutralized. In saponifying, it catches and carries to the bottom the particles of coloring matter and other floating impurities. For this reason the amount of required alkali is determined by making small refinings in bottles in a water bath, with varying amounts of alkali until a sample of refined oil is produced of the desired color and flavor. The percentage of alkali solution (of the strength used) for that particular lot is assumed to be the correct percentage for the entire tank. Within certain limits, the same results may be obtained by using a larger quantity of weak solution or a smaller quantity of strong solution, (the amount of actual caustic soda being about the same in each case). The varying of these ele-

ments to suit varying lots of crude oil gives scope to the skill of the refiner. Generally a weaker solution is used at the beginning of the cotton oil season, when only new oil is refined, a smaller quantity being also required at that time. As the season advances, a stronger solution is used. With the best quality of new crude, an amount of alkali solution of 6 degrees Baume' strength, equal by measure to 4 per cent. of the oil to be refined, will be found sufficient; while later in the season, it may require 15 degrees strength, and 10 per cent in quantity. Crude oil which is not prime (technically "off oil") may require 15 degrees strength and 20 per cent. in quantity. A 700-pound drum of 74 per cent. caustic soda will make about 700 gallons of solution at 15 degrees Baume, or roughly, one gallon to the pound.

An iron tank capable of holding about 130 barrels, and having a conical bottom, and some means of agitating the oil, and some means of heating it, is used for refining 100 barrels of crude. This is considered about the best size, a larger quantity not being capable of sufficient agitation and heating, and a smaller quantity not being as profitable. The oil is measured and pumped in, and the agitation begins. Then a certain quantity of a solution of caustic soda of a certain strength is gradually delivered from the mixing tank over the top of the refining tank through a perforated pipe, which sprays it uniformly over the surface of the agitated oil.

It is important that the solution of alkali put into the oil be evenly distributed in small jets over the surface; otherwise, by reason of its considerably greater specific gravity, it might settle to the bottom of the tank, and thus fail to be thoroughly mixed with the oil, which is the essential point in the whole operation. After the agitation with cold alkali solution has proceeded for a sufficient time to insure perfect mixture of oil and alkali, (say 30 to 40 minutes) the entire mass will have turned almost black. Heat is then applied and the temperature generally brought up to 120 or 130 degrees

(never in good oil above 140), agitation still proceeding. The heating and agitating are kept up till quantities of dark brown flakes separate, and the mass has a curdled appearance. The oil is then dipped up from time to time and filtered through filter paper into successive sample bottles, until one is finally reached which is satisfactory. Or if it is required to produce an oil equal to a given sample, the process may be stopped when the filtered sample from the tank equals that required. It is important to note, in this connection, that a sample kept as a guide for a long time, especially if in a light place, will grow lighter in color, on account of the bleaching action of light. The stearin will also settle out, and the sample will become unreliable. All samples should therefore be kept in a dark place, and should be frequently renewed by duplicates taken from fresh oil.

When the process of refining is judged complete, the heat and agitation are discontinued, and the whole allowed to stand until the floating flakes settle with the excess of alkali. This should occur in about three hours, leaving bright yellow oil in the upper part of the tank. The yellow oil should be drawn off through a large pipe (say 6 inches in diameter), having its end projecting inside the tank with a flexible connection, which will enable the refiner to draw off the yellow oil to any given depth, this depth depending upon the thoroughness of settling, and the amount of sediment (which varies with the quality of the crude oil). The yellow oil drawn from refining tank is delivered into a similar tank below, known as the "finishing tank," where it is heated and agitated again in about the same way, for the purpose of evaporating any entrained water. It is allowed to settle again, and is pumped off through a filter press into storage tanks or into barrels or tank cars for shipment. The filter press removes all sediment, and leaves the oil clear and brilliant.

Some refiners now prefer not to use the filter press. They claim that by settling out the impurities by gravity, the oil is made clearer than by the forced filtration. This process

necessarily requires more tank room in the refinery than when the filter press is used.

If it has been necessary to use very strong alkali, or a large quantity of it, the finished oil may still taste of alkali, in which case it is necessary to wash it. This may be done in a special washing tank or in the finishing tank, after the sediment has been drawn out through the large gate valve at the lowest point of the conical tank bottom. Agitation is then started in the oil, and 2 to 6 per cent. of clean water put in through perforated pipes at the top (the same kind as used for distributing alkali in the refining tank). It is sometimes advantageous to use salt water for washing oil. It is made about 10 degrees Baume'. The purpose is primarily to make the washing water considerably heavier than the oil, so it will settle off more readily; but it is also thought to add to the flavor of the oil. The temperature is brought up to about 100 degrees F., and it is agitated for an hour. Heat and agitation is then stopped and the water allowed to settle for several hours. This water is drawn off at the bottom until cloudy oil appears. This cloudy oil contains some water, and is to be put into a small tank and heated and agitated, to drive off the water. The clear oil in the finishing tank still contains a little water, which must be driven off by heat and agitation. The purpose of separating the small quantity of cloudy oil, containing most of the entrained water, is that its water may be more easily expelled than if left with the large lot. Great care is necessary in heating refined oil, especially when mixed with water. Its flavor is easily ruined by heat. It begins to decompose at about 140 degrees F., and should therefore never exceed that temperature, and be kept as much below that as will accomplish the ends required.

First class crude oil in the early part of the season may, with sufficient skill, be refined at a temperature below 100 degrees F. In working oil by this cold process, no additional heat is applied in the finishing tank, but the water is driven off by agitation. The oil is required to stand quiet

for ten or twelve hours, so that any remaining water may settle out.

With a special view to working at lower temperature, it is well to make the finishing tank large in diameter and shallow, thus presenting the maximum surface for evaporating the entrained water.

But the most perfect way to remove the water at low temperature would be to use a finishing tank with an air tight cover, supplied with a vacuum pump. By this process, the water is vaporized and removed, and any other bad gases or odors are drawn out.

In refining "off oils," which are not sold on a basis of flavor, high temperatures do not damage the quality. Off oil is harder to reduce to a light color than prime oil, and, as it is sold on a basis of color only, and, as higher temperatures produce brighter colors, it is frequently economical to heat these oils as high as 160 or 170 degrees F.

The sediment left in the bottom of refining and finishing tanks is drawn off into a tank below and heated again to separate what oil may have gone down with the sediment. This good oil is skimmed from the top of tank, and the residue is drawn off into barrels with large bung holes, and is sold as "soap stock."

Soap stock consists of saponified oil, water, free alkali and the dark brown coloring matter derived from crude oil. It is sold to soap makers on the basis of contained fatty acids. Fifty per cent. is the standard, but it usually runs about sixty. This is not "free fatty acid," but is in combination, and can be easily separated from combination for use in soap making.

Some refineries utilize their own soap stock, and make crude soaps. Of late years, there has grown up a large demand for this product in wool scouring and other establishments in this country and in Europe. This adds considerably to the profits of a refinery. With sufficient skill, there is no limit to the extent to which this work may be carried, in the way of turning all the products into more and more

valuable commodities. With the admixture of other greases, the finest grades of laundry soap may be made. A soap-making adjunct to the refinery is also useful in using up off grades of oil when their market price becomes low.

Prime crude oil, loses, in being refined to prime summer yellow, 5 to 12 per cent., according to age and general quality. Off oils may lose as much as 20 per cent. This loss is the difference between crude oil and the resulting refined oil, and the percentage is computed on the crude oil supplied. The amount of soap stock deposited is of course greater than the loss in oil, by an amount equal to the alkali solution supplied.

The loss in refining is entirely too much in excess of the theoretical possibility, and the process is much in need of improvement. A logical direction in which to proceed would seem to be toward some bleaching process, but so far, no known bleaching agent except sulphuric acid or its equivalent, has any effect on crude oil. It is obviously impossible to use sulphuric acid in oil intended for culinary use.

Summer white oil is made from summer yellow by agitating and heating with fullers earth, and pumping the agitated mass through a filter press. This filter removes the fullers earth, and delivers fairly white oil, depending for color upon the quality of yellow oil used, and quality of fullers earth, and skill of refiner. Most summer white oil has a taste derived from fullers earth, and this was formerly accepted as necessary. Now, however, white oil will not pass as prime, unless almost water white, and free from taste of fullers earth. In order to produce the color now required, it is necessary to refine the yellow oil to a specially bright yellow, and to use about 3 per cent., by volume, of fullers earth, whereas 1 to 2 per cent. was formerly considered sufficient. This large amount of fullers earth makes the taste more pronounced. Fullers earth is slightly acid to the taste. This acid is now sometimes neutralized, and the taste destroyed, by the addition of 1 to 2 per cent. of carbonate of soda, or, as it is known in the trade, "soda ash."

Only the better grades of soda ash should be used for this purpose. The oil, the fullers earth and the soda should all be entirely free from water or moisture. If the filter press is in good order, the white oil should be brilliant, and there should be no appreciable loss of the oil in the operation. This process, though called bleaching, seems to be principally a mechanical one, and is not well understood.

Pulverized charcoal, especially animal charcoal (or bone black), would do this work of bleaching as well as fullers earth, and leave a better taste in the oil. Its use, however, would cause great risk of fire by spontaneous combustion, which is not attached to the use of fullers earth.

Miners' oil is a white oil that is bleached from yellow oil by the use of sulphuric acid. The demand for this oil is limited, and but few refineries are equipped for making it. The process is conducted in lead-lined tanks. The poorest quality of crude oil may be used for this purpose. It is first refined to a dark yellow, at a small loss, and sulphuric acid bleaches it with but small loss, to any degree of whiteness. This oil is used to mix with petroleum for use in miners' lamps.

Winter oils are those which remain liquid at 32 degrees, F. Ordinary refined oils (summer oils) begin to cloud at 28 to 40 degrees, and become totally congealed at about 30. This cloudiness is caused by congelation of stearin, which turns whiter as it becomes solid. Winter oils are made from summer oils by lowering the temperature just to the point where stearin congeals and olein remains liquid, and separating the two by filtration under pressure at that temperature. Winter oils, therefore are principally olein. Winter yellow is considered the best oil for use in cooking, as a substitute for lard.

Olein does not decompose at high temperature as readily as stearin, so that in using it for frying, it does not give off the disagreeable smell so noticeable with summer oils.

The equipment for producing winter oils is quite expensive, involving the construction of an ice plant, and, as the

demand for the products is limited, few refineries are equipped for making them.

Every operation around the refinery should be conducted with the greatest cleanliness. Floors should be kept scoured, and all tanks and pipes should be kept clean, inside and outside.

Refined oil, when shipped to lard refiners in the West, goes almost exclusively in tank cars. When for export, it is shipped in barrels. When empty tank cars are received, they should be cleaned inside by hand; and then a steam pipe should be inserted and live steam blown in until entire tank is very hot. This melts down any rancid oil or lard that may adhere. It should then be thoroughly washed out with a hose. A man should go inside and scrub it. He should examine every pipe and joint to see that no leaks exist or are likely to develop on the next trip. A carload of oil is so valuable that it pays to exercise every precaution to prevent a possibility of leakage. Most cars are provided with a series of coils of pipe inside for the purpose of heating chilled oil with steam. The two ends of the pipe project through the tank, and, if there is no break in the pipe, no oil could leak out; but these pipes frequently jar loose on a journey, so that it is necessary to plug up or cap the ends before shipping.

Barrels for the shipment of refined oils should be strictly new, made of well seasoned oak with six heavy iron hoops. The head hoops should not extend more than 1-8 inch beyond end of staves, and should be so tight that they cannot be driven more than 1-8 inch below end of staves Barrels should weigh about 70 pounds and hold about 52 gallons. Barrels should be made with the utmost care, from the dryest timber. Even the best barrels will dry out somewhat after being received at the refinery, so that the hoops must be driven tight just before using. After the hoops are driven, the barrels should be lined with silicate of soda, to prevent oil from saturating the wood. Silicate of soda is a soluble glass. It is generally received in barrels,

FIG. 114. Cotton Oil Filter Press.

holding about 600 pounds. It is a heavy viscous liquid of a creamy color, soluble in water, and becoming hard and glassy when dry. It is put with an equal amount of water into a steam jacketed kettle, holding about 20 gallons. It is boiled, and about a gallon poured hot into each barrel. The bung hole is stopped with a long plug, the barrel is shaken in every direction until the hot liquid reaches every part of the inside. The gas generated will force the liquid through any worm holes or other defects in the barrel, so that they may be discovered and plugged up. The plug is pulled out of the bung hole, the surplus liquid poured out, and the barrel laid bung hole down, on an inclined trough, so the drippings may return to the kettle. In six hours the barrel is dry, and after being painted and weighed, is ready for use. It requires about a pound of commercial silicate for each barrel. Formerly, barrels were lined with glue by a process similar to the above; but at best, glue is likely in time to attain a bad smell. Again, if a barrel lined with glue is heated in any manner to melt out oil in cold weather, the glue will also melt and spoil the oil. For these reasons, in the best refineries, glue is no longer used for the purpose.

Some refiners prefer paraffine wax for lining barrels. This is melted and applied in the same way as silicate of soda. No matter what lining is used, care should be taken not to put hot oil into the barrels. Oil should never be barreled warmer than 80 degrees, or in summer, never above the temperature of the surrounding atmosphere.

It requires the greatest care to make barrels oil tight, even before they are shipped; and when they are loaded and unloaded several times, hoops are likely to slip, or leaks develop from other causes. Thus it is imperative that not a single barrel should leave the refinery except in perfect order. If a barrel creaks while rolling on the floor, it is in bad order, and should be driven up or emptied. One leaky barrel in a cargo is likely to smear the whole lot and make the hoops greasy and easy to slip. In many foreign countries, barrels are unloaded by sliding endwise down

skids. This will cause any loose hoops to slip. Two plans are in current use for holding hoops. One is to drive three small special tacks in front of each hoop, and the other to drive a centre-punch into each hoop at about three points, thus producing under the hoop a small projection which drives into the stave. Neither plan is free from objections; the tacks are apt to work loose and hurt the hands of the men who handle the barrels, while centre-punching makes the hoops very hard to tighten, in case it should become necessary.

If second hand barrels are used in any case, they should be thoroughly cleaned out with live steam. A trough is provided, across which the barrels may be laid, bung hole down. A series of ½-inch steam pipes should project up from the bottom of the trough, at the proper distance apart, to stick up a few inches into the barrels. Live steam should be blown into them for at least 15 minutes, more or less, according to what the barrels have contained. It is impossible by any ordinary means, to sufficiently clean barrels having been used for varnish, linseed oil, or crude petroleum. Before second hand barrels are filled, each one should be examined inside by the light of a candle attached to a wire and let down through the bung hole.

A first class refinery for the production of summer oils, to refine 100 barrels at a time, could turn out 200 to 300 barrels per day. The building would be about 30x60, three stories high, with barrel shed 30x60, one story, built to have 120 feet front on railroad siding, giving access to several cars at a time. The equipment would be as follows:

One refining tank to hold 130 barrels, with conical bottom, with 6-inch gate valve in bottom and 6-inch outlet valve two feet above bottom of cylindrical part of tank. Through the side outlet is inserted a pipe with two elbows inside, arranged to let a connecting pipe be raised and lowered inside, so oil may be drawn from any height. In the bottom is arranged a series of steam pipes to heat the oil. It is preferably constructed of 1-inch pipe bent in smooth

coils, making about four complete rounds, one above the other against the side, and also two coils on the bottom. It is frequently constructed in square coils with elbows or return bends. This arrangement is harder to clean, because soap stock will adhere and cake on the fittings. Steam is admitted to the coils through a pipe leading down the side from the top, where the admission valve is placed. The exhaust may go out in the same way, with valve near the admission valve. This is convenient, but not quite so good as to have the exhaust go out at the bottom, so that it may more perfectly drain condensed water from the coils. An ideal refining tank would be made with steam jacket over its entire surface; but this would be more expensive. There are two methods of producing agitation of oil, first by paddles, mounted on a vertical shaft standing in centre of tank, run by bevel gearing and a belt; second by a series of perforated pipes in bottom of tank, through which air is pumped. Either method may produce a perfect agitation and perfect results. Paddles are considerably more trouble to keep in order, and present more surface inside the tank to become foul with soap stock; but there are refiners who claim that they make better oil with this system. The air method has the advantage of carrying away entrained water while passing through oil, especially in the later processes, where oil is washed and dried.

There are, besides the refining tank:

1 finishing tank, of same size and description as refining tank, except that side outlet is unnecessary.

1 bleaching tank for white oil, same as finishing tank.

1 50-barrel tank, same as finishing tank, for sundry purposes.

1 soap stock tank holding 40 barrels, with conical bottom, and steam coil.

1 plain 10-barrel dissolving tank for alkali.

1 plain 30-barrel mixing tank for alkali.

1 plain 60-barrel tank for receiving crude oil which may arrive in barrels.

Storage tanks for crude and refined oils, to suit circumstances, say 3 500-barrel crude oil tanks, and 3 500-barrel refined oil tanks. These may be located outside the refinery, about 50 feet away, under a shed; or the tanks themselves may be made with covers. They should be provided with steam coils to melt oil in winter. They should have manholes, top and bottom, for access in cleaning. Both oil and steam pipes leading to the refinery should be well insulated and laid under ground.

1 50- to 100-barrel elevated water tank.
1 50-horse power steam boiler with accessories.
1 filter press with steam pump.
1 6x4x6 steam pump for crude oil.
1 6x4x6 steam pump for refined oil.
1 6x4x6 steam pump for alkali.
1 6x4x6 steam pump for water supply.
1 7x10x10 steam air pump, if air agitation is used.

If mechanical agitation is to be used, 1 5-horse power steam engine must be supplied. But in case an engine has to be supplied at all, it is bettter to have a large engine, say 25 horse power, and substitute for steam pumps, power pumps throughout. In any case, power pumps are more economical with steam, though steam pumps are more convenient. If it is desired to use power pumps, air agitation may be supplied from a Root blower or other positive blast fan.

The refining tank should be placed so its top is three feet above the third floor of the building; the finishing tank and bleaching tank three feet above second floor; and soap stock tank with its bottom three feet above first floor, and its top just under the refining tank. The alkali dissolving tank should be under the first floor, and the alkali mixing tank above the refining tank. The crude oil receiving tank should be under the first floor, so that barrels may be rolled over it for emptying oil. All the oil steam pumps may be located together in a pump room on the first floor, and all connected to two sets of manifolds, one for crude and one for

refined oil, so that any pump may pump oil from any tank—similar in operation to the switchboard of an electric plant. There should be two entire sets of pipes throughout, one for crude and one for refined oil, both sets being connected to all tanks, so that in emergency one tank may be substituted for another. To avoid mistakes, crude oil pipes should be painted brown, and refined oil pipes yellow. At each turn in the pipes, plugged tees should be used instead of elbows, so that they may be easily cleaned inside.

The refining, finishing and bleaching tanks should be provided with hoods commencing three feet above tank, and terminating in 16 inch galvanized pipes leading out of the building. These carry off the gases and steam. The bleaching tank should be in a separate room, to prevent the fine powdered fullers earth from flying over the refinery.

Soap stock should be handled in a separate room from oil, so that the smells and general uncleanliness of the article may not contaminate the oil.

If air agitation is used, the air supply must come from outside the building, where it is clean and pure. In general, all operations must be conducted with the greatest regard for cleanliness. Refined cotton oil is a delicate article, and may be easily damaged by careless handling.

Part III.

CORRELATED INDUSTRIES.

CHAPTER XIV.

Cattle Feeding.

Both cotton seed hulls and cotton seed meal are excellent food for cattle, sheep and goats. This fact has developed in the South a business in fattening cattle for the market, and has also very much stimulated the dairy business.

The fattening of beef is done to a much larger extent in the Southwestern States than in those of the Southeast. The business is still extending throughout the entire cotton-growing States, and especially where conditions are already favorable to raising stock, as, for example, in the piedmont region.

The business has been somewhat retarded by those who, learning of the value of cotton seed hulls and cotton seed meal as a feeding stuff for certain animals, went into the business of cattle feeding without due consideration of ordinary commercial economies. These over-zealous people paid, in many cases, too much for the cattle purchased, spent too much money on sheds and appliances, and bought cattle that were too small, of inferior breeds, or that had to be transported a long distance, and perhaps acclimated.

There have been cases where cattle feeding was conducted on a spectacular basis, where pens and sheds were located more with relation to public display than to general convenience and economy. In such cases great expense would be incurred in fitting up waterworks, consisting of boilers, pumping engine, piping, etc. The average practical farmer will understand that the time is not yet come when beef cattle may be kept profitably in stalls with baths attached.

To make a success of fattening cattle for market or of conducting a dairy farm, there must be good judgment and economy in the purchase of stock and in the conduct of the business.

While cotton seed meal and hulls may be fed exclusively for the purpose of fattening cattle in from 80 to 100 days, yet on the farm, this commercial material should be regarded more as supplemental to the great variety of feeding stuffs that are naturally and cheaply produced on the farm. In the dairy business, this mixing of the feeds is even more important than in beef business. This improves both the quantity and the quality of the products, and keeps the cows in better health and spirits.

The Southern planter always raised quantities of cattle feed, and previous to the Civil War, even when producing mostly cotton, gave considerable attention to cattle raising. After the War, however, the cattle industry declined in the cotton-growing States until the use of cotton seed meal and hulls became well known as a cattle feed. It it now being more and more realized that these feeding stuffs are of prime importance, and this in turn stimulates the growing of more farm feeding stuffs, in order to improve the cotton industry and produce better feed. Thus the business of feeding cattle on a large scale, both for beef and for dairy purposes has advanced from a very arduous condition to a comparatively easy, as well as profitable one.

Beef Cattle

In the Southwestern States, the business of fattening cattle for the beef markets on hulls and meal at the oil mills, or near them, has become standard, and is extensively done. It is probable that half a million animals are annually fattened on hulls and meal, and sent to market from the cotton States west of the Mississippi River. East of the river, the business is not so well established, but is growing.

Meal is extensively used as a fertilizer, and hulls have also some little value as a fertilizer. When fed to cattle, 80 to 95 per cent. of the fertilizer values may be recovered, and this is done in many cases. The original fertilizing values in both meal and hulls which have been fed are nearly all

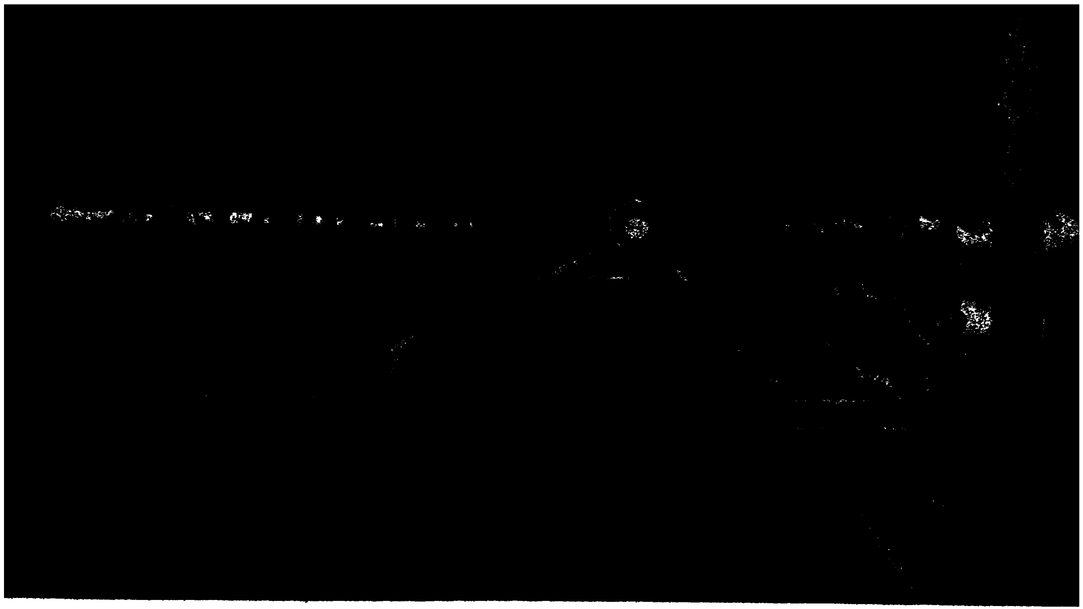


FIG. 115. Interior Cattle Feeding Shed.

in the solid and liquid excrement—approximately half being in the dung and half in the urine. When feeding cattle in large pens, the liquids are practically lost, and it is difficult to collect the solid excrement and keep it in a manner to conserve the fertilizing values. In this way as ordinarily done, there is saved only about 20 per cent. of the original fertilizing value of the meal and hulls. If, however, the cattle are regularly moved from one large pen to another, and the ground promptly put into cultivation, it is possible to realize 80 to 95 per cent of the original fertilizing values. It may also be equally well done if the cattle are carefully stalled, so that by the use of litter and finely cut straw, the liquid may be absorbed and mixed with the solids. The tramping of the cattle helps to compact the manures and prevent loss of ammonia by evaporation.

It is very easy to lose large amounts of ammonia by evaporation. This is the most expensive ingredient in any fertilizer, and no pains should be spared to accumulate it from all natural sources and to prevent its waste by evaporation or otherwise. It is profitable to mix acid phosphate with stable manure to preserve it, and at the same time to thus produce a valuable farm compost. The proper study of fertilizer values is of utmost importance to the profitable conduct of any kind of cattle feeding.

In fattening cattle on cotton seed meal and hulls, the usual practice is to commence with a ration of hulls 18 pounds, meal 3 pounds, (or 6 to 1), and quickly increase to hulls 20 pounds, meal 4 pounds (5 to 1), and toward the end of the period of 80 to 100 days, increase to hulls 24 pounds, meal 6 pounds (4 to 1). This kind of ration and quantity must be governed by circumstances. Some wild cattle from the prairies will not eat the mixture in any proportion whatever, and they have to be starved to it. Other cattle, mostly home-raised, like it from the first; but they all learn to be very fond of it. Care must be taken not to make the ration too rich in meal at first, for the reason that this tends to make the animals "scour."

It is generally assumed that an average steer may be fattened in fine condition for the market on one ton of hulls and 400 pounds of meal.

Figs. 115 and 116 show a form of shed which is sometimes used for fattening steers on cotton seed meal and hulls. The steers are chained to stanchions, with their heads towards the centre alley or driveway, as shown. They have free access to a continuous trough, containing alternate compartments for water and feed. The water is supplied from the city waterworks or otherwise through float valves, so arranged that the troughs are always full of water. The feed is distributed from wagons, driven down the centre.

Fig. 117 shows cattle being fed in open pens. Both methods have been successfully used; but the general opinion prevails that better results obtain when cattle are fed under some kind of shelter. Some successful feeders combine the two plans, and allow the cattle to roam in large pens, and to go under shelter to feed. Much depends upon the kind of cattle fed. Texas steers with wide dangerous horns are hard to manage in the open. When left loose they frequently fight among themselves with fatal results. If the ground for the pens is soft or not well drained, they are apt to mire up, and in many ways dissipate the energy in the feed, instead of storing it up as fat.

The practice of de-horning is now universally recommended, to save room in stalling and shipping, and for general safety in handling.

The following estimates show some average results from cattle feeding, with average market values, but under different conditions:

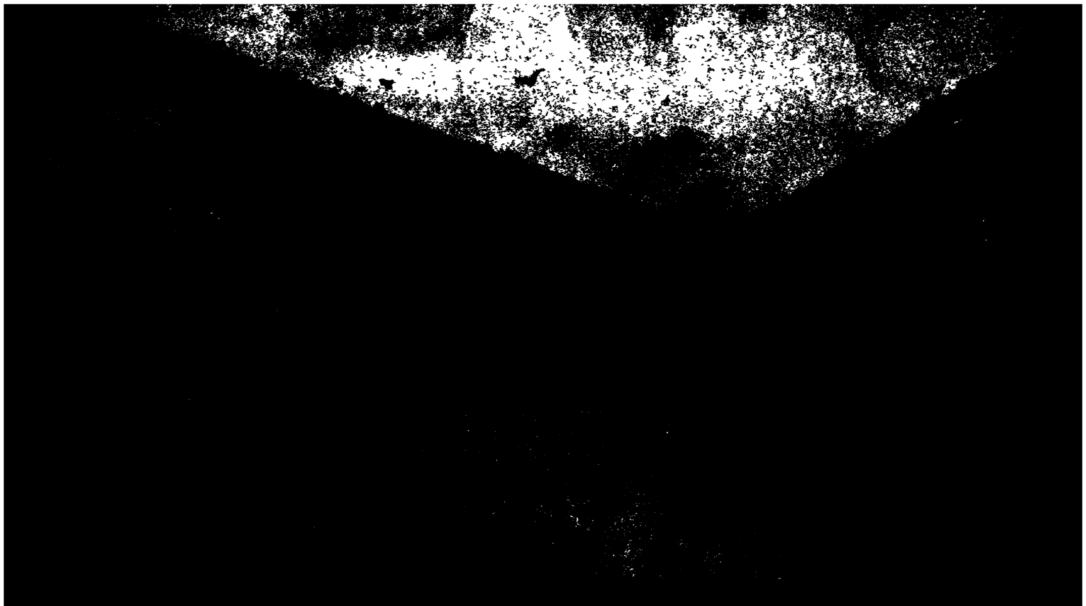


Fig. 116. Exterior Cattle Feeding Sheds.

INDIFFERENT STEER.—INDIFFERENT HANDLING.

Cost of steer, 700 lbs @ 3	$21.00
2,000 lbs hulls	4.00
400 lbs meal	4.00
Attendance	6.00
	$35.00
Sale of fattened steer, 900 lbs @ 3½c	$31.50
Loss	$3.50

This exhibits about an average condition in many parts of the Southeastern States, where the proper care is not given to the breed of animals nor to its handling before or during feeding.

FAIR STEER.—FAIR PREVIOUS HANDLING.

Cost of steer, 1,000 lbs @ 2½	$25.00
2,000 lbs hulls	4.00
400 lbs meal	4.00
Attendance and other expenses	6.00
	$39.00
Sale of fattened steer, 1,300 lbs @ 3½	$45.50
Profit	$6.50

This exhibits about an average condition in Texas.

GOOD STEER.—GOOD PREVIOUS HANDLING.

Cost of steer, 1,200 lbs @ 3c	$36.00
2,400 lbs hulls	4.80
500 lbs meal	5.00
Attendance and other expense	6.20
	$52.00
Sale of fattened steer, 1,600 lbs @ 4c	$64.00
Profit	$12.00

In all these cases, no account is taken of the fertilizer values that may be practically recovered. This may be estimated at an average of say $4 per steer. This credit would bring the example of unprofitable feeding up to a basis of a half dollar profit, besides fair compensation for wages.

There have been special cases where "feeders" (those who fatten cattle for market), have made $20.00 and even higher profits per head; but all very high profits are speculative—the result of a rise in price of cattle between the time of purchase and sale. There are cases also, where from $10 to $15 per head have been lost from the same cause.

The above estimates all relate to the use of hulls and meal alone for feed. In the Southwest, this is the usual practice, and is necessarily so, because at the time when the cattle are usually brought in from the prairie pastures, hulls and meal are the only feeding stuffs that are at the same time good enough and cheap enough to prepare beef for the market. In the Southeastern States, the conditions are very different. On most of the farms there is considerable good pasture land; and on the farms other feeding stuffs are available, such as corn shucks, straw, pea-vines, etc. If the Eastern farmer would make use of all these materials

FIG. 117. Feeding Cattle in Open Pens.

and supplement them with hulls and meal, his results should be even better than those obtained by the Texas ranchman.

If, in addition to this economical system of raising and feeding cattle, with home-raised food stuffs, supplemented by hulls and meal, the Southeastern farmer would improve the breed of his stock, there seems no room to doubt that a very large business would develop in the production of cattle and fattening them for market. Indeed, quite a business is already being successfully done by those who understand it. Thus, the production of cotton, and the raising of cattle are businesses that are supplemental each to the other: the cotton furnishing the hulls and meal as feeding stuffs for the growing cattle, while the cattle manure furnishes the food, as it were, for the growing cotton.

All that is said of cattle feeding is more or less applicable to sheep feeding.

Hulls and meal have been tried for horses and swine, but not with very satisfactory results.

For working oxen, as, for example, at saw mills, there is no better or more economical feed than cotton seed hulls and meal.

There is no reliable published data upon which to base estimates of the extent of the cattle and sheep business previous to the Civil War, but those who have had intimate contact with the business seem to think that in the days of slavery the South was well adapted to cattle and sheep raising, because the labor could be made efficient. Thus all of the attention necessary to the profitable conduct of this business in connection with cotton farming could be commanded. But with the emancipated negro labor, it is not possible to realize more than 80 per cent. efficiency of labor, and hence 80 per cent. of the value of the farm feeding stuffs. Thus cotton seed meal and hulls must be brought in to supply this deficiency. But notwithstanding the enforced purchase of this extra material— or even with the purchase of the entire feeds—cattle may be raised with good profit in most of the cotton growing region.

The best breeds of beef are short-horns and Herefords.

Considerable interest has recently developed in the Northwest in what is called "baby beef." A fine breed of beef calf is fed to fatten from an early age, then sold in a fatted condition at a younger age than usual. The result is said to be very tender and excellent beef at even less cost than by the old method of waiting one or two years before commencing to fatten.

Dairy Cattle.

Some experiments in feeding dairy cattle on cotton seed meal and hulls have erroneously lead to conclusions adverse to the use of these materials for this purpose. These conclusions were hastily reached in regions where other feeding stuffs were plentiful and cheap, and more agreeable at first to the taste of the cattle. This relates mostly to the use of cotton seed hulls. The feeding value of cotton seed meal has now become universally recognized, and it is known that it is one of the very best of feeds, price and results considered. It is, of course, important for every dairyman, who owns a farm, to utilize all the home feeding stuffs; but in the South, it is generally most profitable to supplement them with the cotton seed products. In competing in the markets of the world for beef and dairy products, it seems evident that the South's opportunity lies in the intelligent use of the cotton seed meal and hulls.

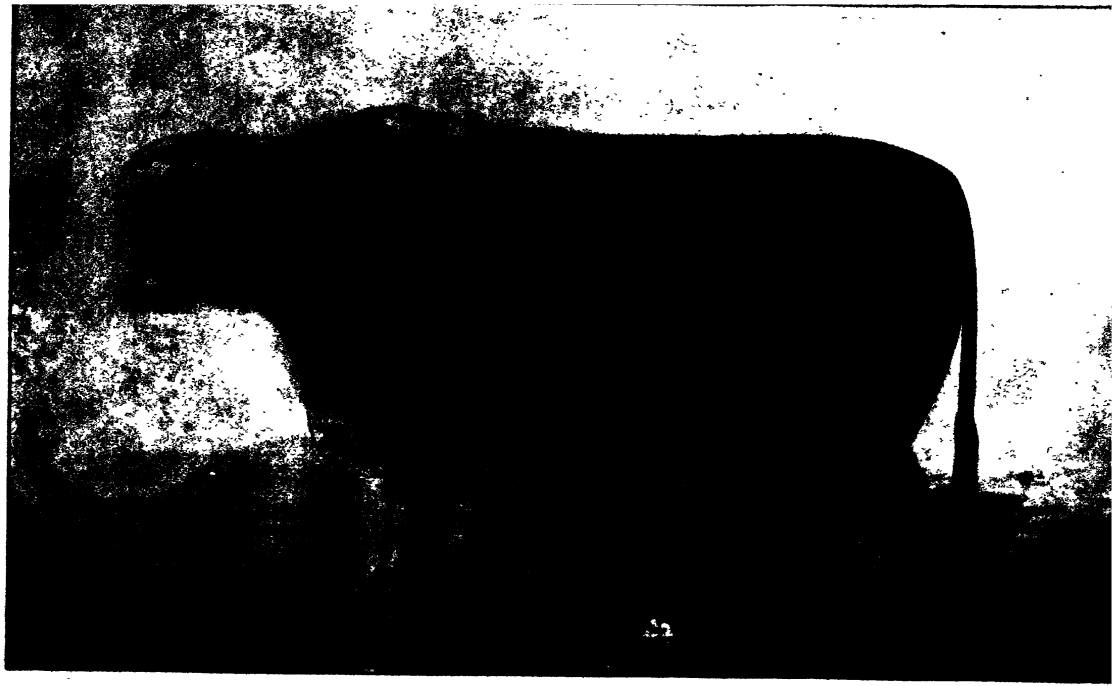


FIG. 118. Hereford Bull: Good Beef Breed.

The following estimates show a series of results (all expressed in round numbers) obtainable from one milk cow, under various conditions:

ILL BREEDING.—ILL FEEDING.—ILL CARE.

Yield per year, milk........................2,000 lbs
Or butter.................................100 lbs

This would be inferior butter, not bringing over 20 cents per pound, so that the income from butter would be $20. This condition may be said to represent the average of North Carolina.

FAIR BREEDING.—FAIR FEEDING.—FAIR CARE.

Yield per year, milk........................4,000 lbs
Or butter.................................200 lbs

This butter would be better, and would sell for say 25 cents per pound, making the income from butter $50. This condition about represents the average of New York State.

SUPERIOR BREEDING.—SUPERIOR FEEDING.—SUPERIOR CARE.

Yield per year, milk........................10,000 lbs
Or butter.................................500 lbs

This butter would be worth about 30 cents per pound, making the income $150.

This represents a good average condition as now existing in Germany.

MAXIMUM BREEDING.—MAXIMUM FEEDING.—MAXIMUM CARE.

Yield per year, milk........................15,000 lbs
Or butter.................................750 lbs

This butter at 30 cents per pound would make the income $225.

The above yields are not by any means impossible. They have even been excelled. There is one record in Germany of a cow weighing 1,100 pounds, producing in one year 17,500 pounds of milk, making 875 pounds of butter.

The same conditions which conduce to large yields also tend to make better values for the products. The first essential is a good breed for the purpose, the next is proper feed, and the next, but by no means the least important, is proper and intelligent care of the animal. This includes proper housing, kind treatment, and an abundant supply of pure water.

The best breed for yield of butter is the Jersey or the Guernsey; the best for quantity of milk is the Holstein or Ayrshire. These have been specially bred for the purposes mentioned, and may generally be relied upon for these respective purpose.

Profitable Yield.

The question as to what is a profitable and what is an unprofitable yield of milk or butter for dairy cows, is necessarily one that involves many factors and these factors all vary. The best that can be done in giving a definite answer is to give figures based upon average conditions. The following figures give what may be considered average profittable yields in the localities stated:

In North Carolina, 3,000 pounds milk or 150 pounds butter per year.

In New York State, 4,000 pounds milk or 200 pounds butter per year.

In Germany, 5,000 pounds milk or 250 pounds butter per year.

If these figures are correct, then the return from the cattle in North Carolina now is not profitable.

With cotton seed hulls and meal as feeding stuffs supplemented by present farm products, and with good breeding and good care, the German yields might be equaled.

If this could be done, then the dairy business in North

Fig. 119. Prairie Steer: Not Good Beef Type—Legs Too Long.

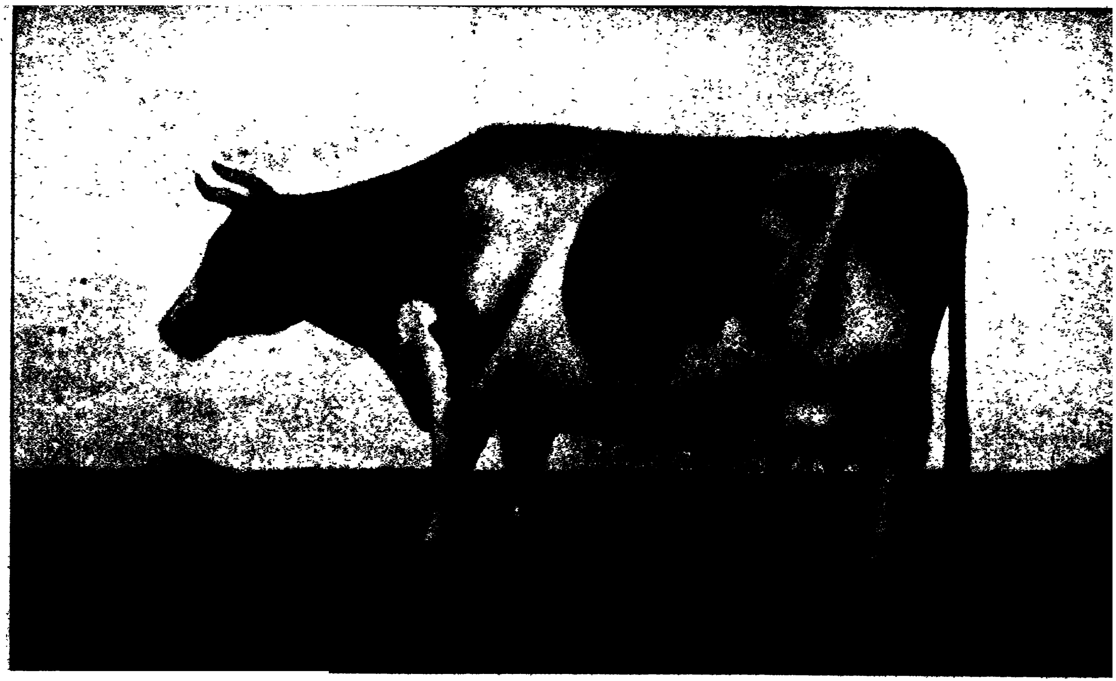


Fig. 120. Holstein Cow: Good Milk Breed.

Fig. 121. Jersey Cow: Good Butter Breed.

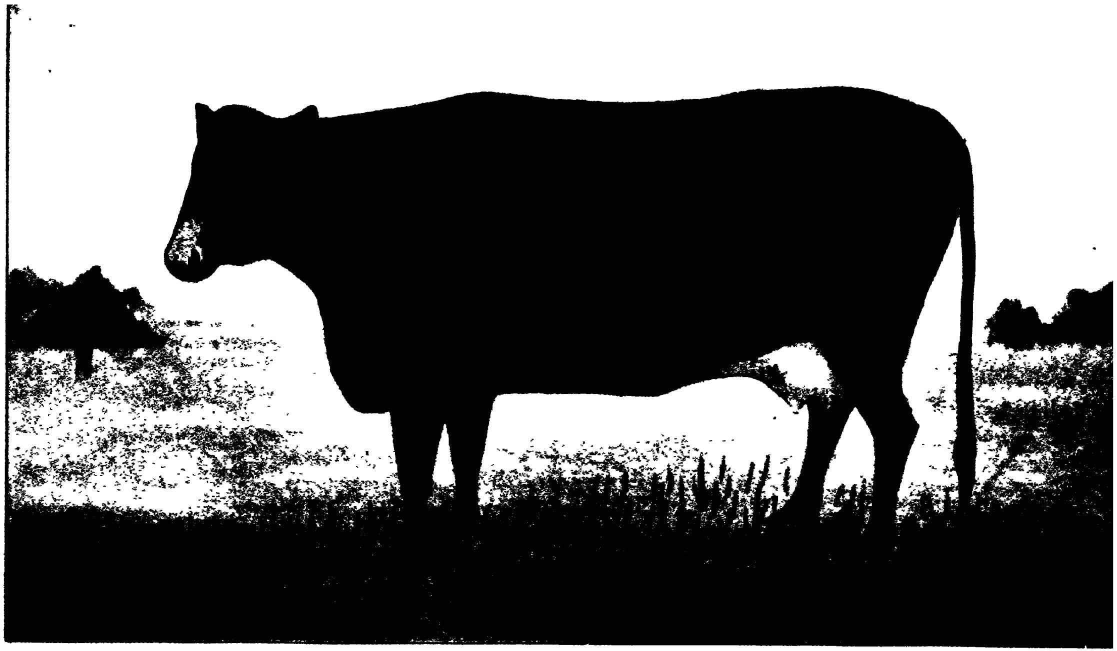


FIG. 122. Scrub Milk Cow.

Carolina, which is, as a rule, now unprofitable, might be made superior to that of New York State as now conducted, and equal to that of Germany as now conducted.

What is here said about the dairy business in North Carolina is equally applicable to most of the other cotton-growing States. This entire discussion is based upon the idea that cotton seed meal and hulls make in nearly all parts of the cotton-growing States ample opportunity for profitable business in raising and fattening beef and in producing milk and butter.

The climate in the cotton-growing area is very favorable to all forms of cattle business. There must always be a certain amount of warmth supplied to cattle. If the weather is cold, the warmth must be supplied by food, and such food as is adapted to the purpose.

Cow Lot Manure.

In all dealings with cattle, whether keeping them for beef or for dairy products, provision should be made to utilize the manure. Besides the fertilizing values in cow manure for increasing production, this particular manure has in some way, not understood, the power of improving the length, strength and fineness of the staple of cotton.

It is said that in the production of mushrooms, even when all other conditions are favorable, when leaf mould and horse manure is used, the result is indifferent; when using cattle manure, the result is still indifferent; but when the two are mixed, the results in prolific yields, is little less than wonderful. So, in some way, not fully understood, cattle manure, when mixed with other manures improves the quality of the cotton fibres produced. The use of commercial or chemical fertilizers alone, as compared with the use of barn-yard manures, (either alone or in combination), tends in some measure to degenerate—or at least not to improve—the quality of the cotton crop. Chemical fertilizers are clean, and therefore more agreeable to handle. They also contain con-

centrated plant food, and in many cases are necessary to get large yields, and maintain soil fertility.

The development of the business of making commercial fertilizers has been of immense advantage to the cotton producing interests; but it has also been productive of some harm in making the farmers less careful about saving and utilizing home manures. It is manifestly extravagant to buy commercial fertilizers when home manures, might, by a little labor, be used for the same result; and this is accentuated when it is considered that the cotton produced by home manures tends toward better qualities.

It is safe to say that the indefinite use of commercial fertilizers would not permanently increase, or even maintain soil fertility. There is an old adage:

> "Lime and marl without manure,
> Will make both farm and farmer poor."

This applies equally as well to any kind of artificial fertilizer. This view of the matter is not antagonistic to the makers of chemical fertilizers. The prosperous farmer will always want more fertilizers to mix with his home manures than the thriftless farmer will who relies entirely on commercial fertilizers.

Because of these relations of the cow lot manure to the other fertilizers used for the production of cotton the development of those businesses into which cattle enter—the dairy and beef interests—become at the same time easier and more important.

The raising and handling of sheep would seem to be equally easy, attractive and profitable, except for the fact that in the rural districts, where cotton is produced, a dog seems to be more popular than a sheep.

Considering, (1) the values that have been found in cotton seed, (2) the application of some of these values as stock feed in producing beef and dairy products, (3) the values of the result and manures in producing more cotton, better cotton and more seed, it becomes apparent that there is

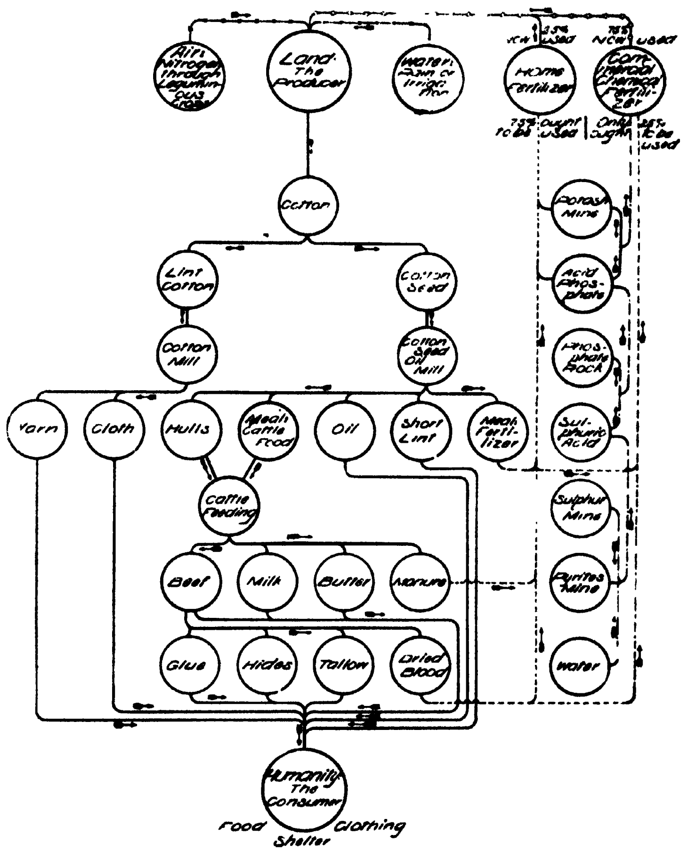


FIG. 123. A Cycle of Production, Consumption and Land Restoration.

a cycle of operations, out of which come valuable products for the markets—human food, clothing and shelter—while all residual products contribute to continue and even extend the cycle of operations. Based upon these ideas, there has already been built at one point in the South a comprehensive plant providing for the following operations:

1. Ginning cotton.
2. Operating an oil mill.
3. Operating a cotton mill.
4. Mixing fertilizers.
5. Feeding cattle.

With the addition of a cotton farm, the above plant would complete the whole cycle of operations.

In this cycle of operations, a number of products are being constantly drawn out for the uses of humanity, and the drafts thus made upon the soil replaced by products brought from the mines or other sources, and prepared chemically to take the place of the withdrawn elements.

The failure to save the residual manures, when these market products are consumed, makes the necessity for the drawing on the outside sources (chemical fertilizers) much greater than it should be.

The diagram, Fig. 123, exhibits the working of this cycle.

Under a proper system of agriculture it should not be necessary to rely to such a great extent upon the mines and chemical works for restoring fertility to the soils, in return for the drafts made upon it by humanity. On the average farm, these drafts could be returned to the soil many fold if full attention is paid to systems of rotation, including leguminous crops, and full attention to the conservation of decomposing vegetation in fields and wooded lands. Large amounts of this are now annually wasted. The stable and barn yard manures that are now allowed to dissipate could be made to yield large returns, especially when used in conjunction with commercial fertilizers to increase their agricultural values. The question of how much commercial fertilizer to use in connection with the home manures is one

of costs and values of products. Every farmer ought to save more home manure than he now does, and ought also to buy more fertilizer than he usually does. The average cotton farmer has time and to spare to do the first; the money he would put into the second would, in combination with the first, make ample return in more yield and finer quality than ever before.

It is said that the civilization of any community may be measured by the consumption of sulphuric acid. Measured by this standard, the southeastern United States would probably surpass any other part of the world. That this is not true is well known. Unusual activity in the production of cotton, and the extension of the fertilizer business to keep pace with it, has caused an abnormal production of sulphuric acid in this section. If other conditions of civilization could be brought up to the level of the consumption of this commodity, then the above measure would be correct. This would involve the preservation and use of home manures to an extent proportional to the commercial fertilizers, and would involve the growth of other manufactures and arts up to the point of normally consuming the sulphuric acid now manufactured. When these proportions shall have been adjusted, then it may be said that the civilization of the Southern States of America may be measured by their consumption of sulphuric acid.

Domestic Use of Meal and Hulls Outside the Cotton Growing States.

The values in cotton seed meal as a stock feed are sufficient to warrant its shipment to, and profitable use in any part of the United States. Great quantities go to many parts of the United States outside of the cotton-growing area, and its value has become well known, especially in New England and other Atlantic coast States.

The hull cannot be profitably sent so far, but many of the oil mills prepare a food made up of about 5-6ths hulls and 1-6th meal, and find extensive sale for this, in sacks, in many

of the Northern States. The hulls alone are put up in compressed bales, and in this form are extensively shipped to adjacent Northern States.

Exports.

The cotton seed meal is very extensively exported for use as cattle feed. Germany takes very large quantities, in the shape of finely ground meal. Most of what formerly went to England was in form of the cake, as it comes from the press. This cake was cracked with a hammer or other suitable instrument, and the broken pieces fed to the stock. Now the demand is for more meal and less cake. Those familiar with the subject consider the ground meal much the best form for feeding.

The hulls are too cheap and bulky to export.

Assuming that by the use of cotton seed hulls and meal, a large and profitable business in beef and dairy cattle can be developed, there will naturally come about other businesses supplementary to these, as for example, in hides, horns, tallow, glue, lard, candles, etc.

The values of lands would increase, because of demand for pasturage, and of increased crops made by the full use of stable and cow lot manure. Oil mills could be more profitably operated, because of the better and nearer markets for their products in hulls and meal.

The agricultural experiment stations of the various cotton growing and some other States, have very full data in the shape of bulletins relating to the digestibility of hulls and meal, and to the experimental and theoretical values of these for fattening beef and for the production of milk and butter. These are sent free to any one who may wish to pursue the subject in detail.

In the appendix of this book may be found some tables and other literature on this subject, which have been compiled from these and other sources.

Splenetic or Texas Fever.

Without undertaking to enter into any general discussion of diseases of cattle, it would seem desirable to call attention to Texas fever, with a synopsis of the government regulations in the matter of quarantine against this disease.

In shipping cattle from the Southern States to Northern markets, across the quarantine line, all quarantine regulations must be complied with. This quarantine line runs across the entire United States, reaching at some points well to the southward, and at others far to the north. The map in the back of this book shows, approximately, the present location of this line. The location of the line is frequently changed, and hence this map must not be relied upon to represent the exact line at all times. The United States Bureau of Animal Industry issues new maps from time to time, together with bulletins, containing revised rules for the transportation of cattle north across the line.

The present rules allow cattle to be shipped North across the line only for immediate slaughter, and even then only under certain regulations, about as follows:

All cars or boats carrying such cattle shall bear printed placards with letters 1½ inches high, stating that the cars or boats contain Southern cattle. All conductors' way bills, etc., must have the same information plainly stamped across the face. No boat carrying Southern cattle shall receive on board any other cattle at the same time.

No boat shall receive cattle to transport North across the line to any point not provided with proper pens, etc., to receive them without having to pass over a public highway, unless permission for same is given by the local authorities.

All cars and boats used for transportation, after unloading must be cleaned and disinfected with lime and carbolic acid.

When cattle are unloaded to be fed or watered in transit, they must be put in pens or yards set apart for infected cattle. No other cattle are to be admitted to these pens while so occupied. Pens are to be cleaned and disinfected with lime and carbolic acid, after the cattle have been moved. The removed litter and manure is also to be disinfected.

CHAPTER XV.

Fertilizers.

Before agriculture became anything of a science in the Southern United States, the cotton crop was infinitely less important than at the present day. The Agricultural Department of the National Government knew nothing of the subject of cotton culture, and the separate States had not then established experiment stations.

Nothing was known in a general and systematic way of the theory of cotton planting. Each planter proceeded according to individual ideas, based on personal experience. Fertilizing cotton was done in a desultory way, with the natural materials at hand, principally stable manure. As this material was entirely inadequate to the requirements, and as commercial fertilizers were then unknown, the cotton plant was never sufficiently nourished. In about 1850, Peruvian guano was first brought to notice as a fertilizer. This is a natural guano, formed by the deposits of birds on South American Islands. It was at that time enormously expensive, compared with the present intrinsic value of fertilizers. It was soon discovered that the use of this guano increased the yield of cotton about 100 per cent., and, as the price of cotton was then relatively high, its use was attended with great profit, and it attained extensive popularity for all other agriculture, as well as for cotton planting. This soon exhausted the world's available supply, and chemists began to experiment with a view of producing substitutes. They discovered that phosphoric acid was the principal ingredient in this manure. At the same time it was experimentally discovered in the course of scientific investigation on the farm, that phosphoric acid was the principal requirement of the cotton plant; but it was also found that there were necessary to the proper nourishment of the cotton plant, nitrogen and potash; hence there was soon developed an

immense industry in producing what was first called "artificial fertilizers," all embracing in a more or less empirical proportion, these three ingredients.

Of late years, this subject has been reduced to a mathematical basis, and the approximate amount of each ingredient necessary in the production of the cotton plant has been accurately tabulated. The method of discovering these chemicals is obviously (1) to determine what chemicals are contained in the plant itself; (2) from what source these chemicals may be derived, that is: whether from air, moisture or earth; and, since air and moisture, as well as some other properties in the earth are supplied by nature; (3) to determine what earth constituents are lacking in certain localities. The determination of the first matter is of universal application; the second depends upon local conditions, while the third is a matter principally for intelligent deduction.

TABLE XVI.

CHEMICAL ANALYSIS OF 10,000 ENTIRE COTTON PLANTS GROWN ON 1 ACRE SHOWING FERTILIZING ELEMENTS IN EACH PART.

PART OF PLANT	WEIGHT OF PART		PHOSPHORIC ACID P_2O_5		NITROGEN N		POTASH K_2O		TOTAL ELEMENTS		
	Pounds	Per Cent.	Pounds	Per Cent.	Pounds	Per Cent	Pounds	Per Cent	Pounds	Per Cent of Parts	Per Cent of 97.30
Lint,	300	10.6	.18	.06	.72	.24	2.22	.74	3.12	1.04	3.2
Seed,	654	23.0	6.06	1.01	20.08	3.07	7.61	1.1[illegible]	34.36	5.25	[illegible]
Bolls,	404	14.2	1.14	.28	4.51	1.11	12.20	3.02	17.84	4.41	18.4
Roots, Stems Leaves,	1483	52.2	4.17	.28	20.64	1.39	17.06	1.15	41.87	[illegible]	43.0
Totals	2841	100	12.15	4.2[illegible]	45.94	1.62	39.11	1.3[illegible]	[illegible]7.30	13.56	100

Table XVI. exhibits the respective amounts of phosphoric acid, nitrogen and potash contained in the several parts of 10,000 cotton plants which produced 300 pounds of lint cotton per acre, which may be taken as a fair average crop, in the Southeastern United States. This bears no exact ratio to the amount of these chemicals which should be added to the soil in any particular locality, from the fact that nitrogen is largely derived from the air, and that the other elements are contained in a greater or less degree in all soils. Furthermore, the application of any given amount of these chemicals to any particular soil, is no guarantee that the cotton plant will take them up from that soil in any prejudged proportion. The table is valuable, however, as a basis, and also as exhibiting the amount of fertilizers consumed by each particular division of the plant. It exhibits, for instance, that lint cotton, the principal commercial article for which the plant is grown, actually removes from the soil only 3 per cent. of the total amount required by the plant. The seed, which is also in most localities a commercial product, removes 35 per cent. This shows that it is necessary in estimating the commercial value of the seed to take into account the money value of the fertilizing chemicals which it carries with it. It also prompts the inquiry, as to what portion of this seed actually covers its commercial value, and whether that particular portion involves any of the fertilizing chemicals. The principal value of seed to commerce is in its oil, which chemical analysis shows does not contain the fertilizing chemicals. It therefore follows, that in the economy of cotton planting, if seed is removed from the soil, arrangements should be made to return the fertilizing elements thereof. It transpires that in the manufacture of cotton seed oil, the fertilizing residue is preserved in cotton seed meal, and is made available for return to the farm. Its principal value is in its nitrogen; and, as will be hereafter shown, its most economical consumption as a fertilizer is in connection with other ingredients, supplying the other two requisite constituents for fertilizers.

TABLE XVII.

AMOUNT OF FERTILIZING ELEMENTS NECESSARY TO BE SUPPLIED TO AVERAGE SOIL IN SOUTHEASTERN UNITED STATES FOR PRODUCTION OF EACH 300 POUNDS OF LINT COTTON PER ACRE.

	Pounds per acre
Phosphoric acid (P_2O_5)	50
Nitrogen (N)	20
Potash (K_2O)	15

Rotation and Diversification of Crops.

Farming is a business having many different phases, capable of correllation, each with all the others. In most practice, the rotation of crops complementary to each other, the production of crops and live stock in a way to make them complementary to each other, and even of bringing the farm in its crop and live stock products into co-relation with the local manufacturing conditions are neglected.*

While cotton may be successfully grown indefinitely on the same piece of land, this is only possible by the annual application of some form of fertilizer. In order to make the best and cheapest restoration of the land there should be rotation of the cotton with grain, considerable stock with pasturage and leguminous crops.

In the ordinary use of commercial fertilizers on land for cotton, the phosphoric acid tends to accumulate in the soil, while the nitrogen tends to diminish.

A grain crop following a cotton crop utilizes plant food in the soil to best advantage: (1) It makes pasture, (2) it fills in with a good crop what would otherwise be a gap in the rotation.

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* See Cotton Mill, Commercial Features, Chap XV. "Farm and Factory."

Cowpeas and clover draw nitrogen from the air, storing it on an average 10 per cent. in the roots, 40 per cent. in the stems and leaves, and 50 per cent. in the peas. The pea hulls contain practically no nitrogen. When a pea crop is raised, the most value is obtained: (1) By cutting the crop for hay, feeding it to cattle and other stock and returning the stock manure to the land, or by pasturing stock on it; (2) by turning the whole crop under. If the peas are picked off and the plant turned under, about half the nitrogen value of the crop is given to the land.

If the crop is mowed and cured for hay, and the roots and residual stems and leaves plowed under, about 25 per cent. of the nitrogen value of the crop is returned to the land.

Many farmers have an idea that nitrogen taken from the air is stored by leguminous crops in the roots, and that the crop may be cut and cured for forage without sacrifice of the nitrogen value of the crop to the land. This is an error. Leguminous crops furnish nitrogen to the soil very much cheaper than it can be procured in any other way. It is practically the only way a cotton farmer can afford to put on enough nitrogen to make profitable crops and keep up his land. Most farmers know this, but don't prac ice it. When the practice does become general, a revolution in the production of cotton will have been accomplished.

Soil Requirements.

Table XVII. exhibits from experimental data, the actual amounts of fertilizing chemicals which should be applied to the soils above alluded to, for the maximum results in the production of the afore-mentioned 300 pounds of lint per acre.

This table is based on a soil which, from its nature, could not profitably yield more than the above amount. The table, however, may be used in the same proportions for soils more productive than this. Just the maximum yield of lint cotton, which it may be profitable to force from a given area, must be determined by actual experi-

ment on the particular soil in question. If it is found that double the stated yield can be profitably forced, then the quantities shown in Table XVII. must be doubled to produce that yield at the minimum cost. But even the use of this table must be tempered with judgment, as to the general character of the soil, both chemically and physically. It has been found by experiment that the three ingredients, to produce the best results, must be applied in a mixture with proper proportions of each. Any one of the three may be of benefit to the cotton plant if applied separately, but the three applied as a mixture will produce a result greater than the sum of the results from each of the three applied separately.

Having determined that certain amounts of phosphoric acid, nitrogen and potash are essential in the complete cotton fertilizer, the question arises as to the best sources from which they may be procured. This question is easily answered in the United States by the various competing fertilizer manufacturers, all of whom manufacture in available forms, fertilizers containing the ingredients in proper proportions. Under the care exercised by State boards of control, and agricultural stations, the farmer cannot go far wrong in accepting the commercial fertilizers offered for sale in his own State. It may be well, however, to call attention to the fact that there is some difference in the agricultural value of the fertilizing chemicals, due to the source from which they are derived. The analyses as published and branded on the sacks are always careful to differentiate the soluble from insoluble phosphoric acid, so that in this respect, it is easy to select the best. All forms of nitrogen in commercial fertilizers are soluble, and hence no difference has been specified in the standard analysis. But there are differences in the rapidity of solution, among the various forms in which nitrogen is supplied. For this reason, it is important for the farmer to ascertain what form of nitrogen he is buying. For example, the nitrogen from nitrate of soda is so quickly soluble that it leaches away before the

cotton plant can utilize it all. This is a valuable form of nitrogen for some plants, such as early vegetables, where quick growth is desirable, but is not recommended for cotton. Sulphate of ammonia and dried blood are good sources of nitrogen, though some think not so good as cotton seed meal, which is less readily soluble, and hence is good to give out the nitrogen as the growing plant requires it. Tankage is variable in composition, and solubility, but is apt to be too slow of solution.

TABLE XVIII.

COMMERCIAL SOURCE OF THE FERTILIZING CHEMICALS, SHOWING AVERAGE PER CENT. OF ACTIVE PRINCIPLE IN EACH.

	Phosphoric Acid per cent.	Nitrogen per cent.	Potash per cent	Equivalent Ammonia per cent.
Acid Phosphate . . .	15.00			
Boneblack	18.00			
Sulphate Ammonia .		20.50		24.89
Nitrate Soda		15.75		19.12
Cotton Seed Meal . .	2.75	7.00	1.75	8.50
Cotton Seed	1.30	2.50	1.20	3.04
Stable Manure . . .	.25	.50	.50	.61
Cotton Hull Ashes .	9.00		22.50	
Wood Ashes	1.75		6.00	
Muriate Potash . . .			50.00	
Sulphate Potash . .			50.00	
Kainit			12.00	

Table XVIII. exhibits these sources, together with the per centage possessed by each. The manner of building up a fertilizer in any given ratio may be easily computed from this table by selecting the most available sources in any particular locality. The following examples will exhibit more clearly the utility of this table.

Making Fertilizers.

To produce a fertilizer containing in a given gross weight:

Phosphoric acid	50 lbs.
Nitrogen	20 lbs
Potash	15 lbs.

EXAMPLE 1

Acid phosphate	333 lbs.	(x. .15=50 lbs.)
Sulphate ammonia	98 lbs.	(x. 20.50=20 lbs.)
Muriate potash	30 lbs.	(x. .50=15 lbs.)
Weight of mixture	461 lbs.	

Entire mixture would analyze:

Phosphoric acid	11.8 per cent
Nitrogen (equivalent ammonia 5.2)	4.3 per cent
Potash	3.3 per cent

EXAMPLE 2

Acid phosphate	281 lbs
Cotton seed meal	286 lbs
Kainit	97 lbs
Weight of mixture	664 lbs

Entire mixture would analyze:

Phosphoric acid	7.5 per cent
Nitrogen (equivalent ammonia 3.6)	3.0 per cent
Potash	2.3 per cent

Transportation of Fertilizers.

It will readily be seen from these examples how an infinite number of changes may be made, with the commercial sources named to produce any desired ratio of fertilizing chemicals. In computing the ultimate cost of any mixture, the cost of transportation from market to farm assumes considerable importance. It will be seen that in Example 1, the required amount of fertilizing chemicals is contained in a mixture weighing 461 pounds, while in example 2 a smaller result requires a mixture weighing 664 pounds, nearly 50 per cent. heavier. Therefore, if the transportation per pound were the same in each case, that part of the cost would be 50 per cent. greater in one case than in the other. It follows in general, that where transportation is of any consequence, the fertilizers having highest percentage of ingredients are most desirable.

Table XVIII., while giving the commercial sources of fertilizing chemicals does not fully indicate the sources in nature from which these commercial articles originate. It may be of value to briefly refer to some of these original sources.

Acid phosphate is commonly derived from fossilized rock, found in many places on the sea-coast and sometimes in the interior, at places supposed to have been originally covered by the ocean. This rock is believed to be the petrified remains of fishes and other marine animals. This rock is mined, dried and ground into fine powder, and treated with sulphuric acid, which renders the phosphoric acid soluble.

There are other sources of phosphoric acid, such as Thomas slag (50 per cent. available) and bone meal (20 per cent. available). It has been abundantly proved by experiment that phosphoric acid, to benefit a cotton plant, must be soluble, so that the plant may avail itself of the total amount applied each season. There is current in some localities a popular idea that the less soluble forms are valu-

able for their lasting qualities in making the ground permanently rich; but such supposition is not sustained by the facts, from a commercial point of view.

Nitrate of soda is a natural product, mined in some parts of South America.

Cotton seed meal is a by-product in the manufacture of oil from cotton seed.

Kainit is a natural product mined in Germany.

The names of other items in the table mostly suggest their origin.

While the value of fertilizing the cotton plant is an acknowledged axiom, it must not be forgotten that the ultimate value depends upon moisture, natural or artificial. It is impossible for any plant to assimilate any fertilizer in the solid state, and hence it is essential (1) that the fertilizer should be soluble, either in water or by action of plant roots in presence of moisture, (2) that there should be moisture sufficient for their solution, (3) that this moisture should not be so abundant as to wash the fertilizers out of the reach of the plants.

With the proper understanding of the subject, excellent results in making fertilizers may be attained on the farm, without the use of any machinery whatever. From Table XVIII. may be selected a list of materials which are the cheapest or most available for the locality. From the analysis it is easy to compute the quantities required to produce a fertilizer of any desired composition. These may be thoroughly mixed by weighing out the ingredients and scattering them in thin layers, one after another in a bin on the floor, and then mixing them all together with a hoe or rake.

There is generally a considerable saving to the farmer in thus mixing his own fertilizers. He would save the profit of the fertilizer factory, and in most cases the profits of middlemen, and save something in freight and hauling. At first sight it might seem that the items of transportation would be the same, whether the materials were bought separately or bought ready mixed; but there are several causes which con-

tribute to making a difference. In the first place, the average commercial fertilizer is in dilute form. The average analysis is approximately:

	Per cent.	Pounds per ton
Phosphoric acid................	9	180
Ammonia (from nitrogen).......	3	60
Potash	2	40
	—	——
Total weight of active principle..	14	280

There is no serious fault to be found with this analysis, from the standpoint of plant-food. The best results in feeding plants, (as well as animals), obtain when the actual nutritive ingredients are in dilute form. But it is highly wasteful to pay for freighting and hauling 2,000 pounds, to get 280 pounds of plant food. If it were practicable for the farmer to obtain the 280 pounds in a pure state, he could dilute it with dirt up to 2,000 pounds and have a fertilizer equally as good as before, and at the same time save 86 per cent. of the cost of transportation. But the cost per pound of the chemicals is somewhat greater, the more concentrated the form, and hence the particular form in which to buy them, is a matter to be considered in each case on the basis of the current market values and the cost of transportation.

Most farms in the cotton-growing area are able to obtain cotton seed meal from local oil mills, and would thus use that as a cheap source of ammonia. The use of cattle manure in connection with other ingredients, helps in keeping down the cost.

If systematic attention is paid to saving cattle manure, especially in cases where cattle raising is made part of the farm programme, there can be almost enough nitrogen produced at home to make all fertilizers. As this is the most expensive item in fertilizers, it is highly important to arrange the whole farming system with reference to this point.

The manner of collecting and preserving cattle manure

deserves some consideration. When cattle are fed in open fields, the manure can be most cheaply utilized by transferring the cattle, and cultivating the land. If cattle are fed in pens, the manure should be piled into compact masses, and kept moist. The less contact it has with air, the better. The use of cut straw and other litter helps absorb and preserve the liquid manure. If the animals lie on the manure or trample it down, it serves the same good purpose as otherwise compacting it. But in such cases, the manure should be utilized as soon as the animals are removed, or it would become dry and otherwise deteriorate.

The mixing of acid phosphate with stable manure serves the double purpose of preserving its qualities, and of making a proper fertilizer. About 2 pounds of acid phosphate per day per head of cattle is a good rough rule. In making any kind of home mixture, the combination of lime or ashes with acid phosphate should be avoided. This would tend to make the phosphoric acid insoluble.

The analysis of most commercial fertilizers contains the item "ammonia," while some contain the item "nitrogen" instead. Ammonia is composed of nitrogen 14 pounds, hydrogen, 3 pounds. It is easy in all computations to convert one to the other by the use of this proportion. Nitrogen is the element that costs money. The hydrogen is derived from water. A fertilizer said to contain 3 per cent. ammonia, may also be said to contain (fourteen-seventeenths of 3) 2.48 per cent. nitrogen, and vice versa.

To produce a fertilizer having any given analysis, say:

	Per cent.	Pounds per ton
Phosphoric acid.............	9	180
Ammonia	3	60
Potash	2	40

A variety of mixtures might be made, as per examples given below, using the analysis given in Table XVIII.

The number of pounds of each ingredient is found by

dividing the amount of chemical required by the percentage composition of the ingredient.

If 180 pounds phosphoric acid is required, and the phosphate contains 15 per cent., the amount of phosphate required is 180÷.15=1,200 pounds.

EXAMPLE I.

Acid phosphate (180÷.15)	1,200 lbs
Cotton seed meal (60÷.0850)	700 lbs
Muriate potash (40÷.50)	80 lbs
Adulterant	20 lbs
	2,000 lbs

This table does not give exactly correct results for the reason that cotton seed meal contains (besides ammonia) small amounts of phosphoric acid and potash, which for simplicity have in this case been neglected.

The adulterant might be omitted, in which case the analysis would run higher in all the items.

EXAMPLE II.

Acid phosphate (180÷.15)	1,200 lbs
Sulphate ammonia (60÷.2489)	240 lbs
Kainit (40÷.12)	333 lbs
Adulterant	227 lbs
	2,000 lbs

EXAMPLE III.

Acid phosphate ($180 \div .15$)	1,200 lbs
Sulphate ammonia ($60 \div .2489$)	240 lbs
Muriate potash ($40 \div .50$)	80 lbs
Adulterant	480 lbs
	2,000 lbs

A popular and cheap mixture is:

Acid phosphate	1200 pounds
Cotton seed meal	600 pounds
Kainit	200 pounds
	2000 pounds

According to the analysis in Table XVIII. the contents of the mixture would be:

Phosphoric acid	9.80 per cent
Ammonia	2.55 per cent
Potash	1.75 per cent

All such mixtures as the above, whether home made or from fertilizer factory, are generally known as "manipulated fertilizer," or as "ammoniated fertilizer."

Commercial Value.

Most of the State governments issue bulletins, from time to time, giving the market value of the fertilizing chemicals, as calculated from the market value of the usual crude materials containing them. Thus if an acid phosphate is sold in the market at $12.00 per ton, and analysis shows it to contain 15 per cent. available phosphoric acid, there would be 300 pounds phosphoric acid sold for $12.00, which would

make a valuation of phosphoric acid, in that shape, four cents per pound.

The average values assigned to these chemicals are about as follows:

Phosphoric acid	4c per pound
Nitrogen (equivalent to ammonia, 10c)	12c per pound
Potash	4c per pound

At these prices, the last mentioned mixture would contain chemicals of the following value:

Phosphoric acid, 196 lbs.@4c	$ 7.84
Nitrogen, 51 lbs.@12c	6.12
Potash, 35 lbs.@4c	1.40
Total value	$15.36

By referring to the bulletin valuations, and examining the analysis of any fertilizer, it is easy to calculate the cost of the actual ingredients, and thus determine whether it would pay better to purchase the ready mixed fertilizer at the price asked, or mix an equivalent at home.

The "commercial value" must not be too implicitly relied upon as an absolute guide. It should be treated as giving information as to relative values of different fertilizers offered for sale. The "agricultural value" is, of course, the final test, and this must of necessity be determined by actual experiments with any given fertilizer for a given crop on a given piece of land. Even these experiments are subject to some variation, due to variations in the rainfall and other weather conditions.

Mixing Fertilizers at Oil Mills.

Cotton seed meal forms an acceptable ingredient of mixed fertilizers, and it is, therefore, logical that the oil mill should undertake the mixing of fertilizers as an adjunct to the

business, and it has been widely and profitably done. The cotton seed meal may be delivered in bulk by conveyors to the mixing room, thus saving the expense of sacking.

The mixing machine may be very simple and inexpensive. It has even been profitably done by hand, using a hand screen for sifting out the lumps.

A good form of mixer is shown in Figure 124.

Fertilizer Mixer, Fig. 124—Lettering.

A.—Hopper to receive the ingredients.
B.—Elevator belt or chain.
C.—Elevator cups.
D.—Pulley in elevator head.
E.—Pulley in elevator boot.
F.—Material going into mixer.
G.—Ribs of revolving reel.
H.—Driving gears.
J.—Rolls to crush lumps.
K.—Knives to scrape rolls.
L.—Conveyor to take mixed fertilizer.
M.—Spouts to hold bags.
N.—Gates to admit the fertilizer to either spout as desired.

Process.

Have adjacent to the feeding hopper two shallow bins, say 10 feet square and 2 feet deep. Each bin will hold about five tons. Weigh the ingredients into one of the bins, one or two hundred pounds at a time, according to the formula decided upon, making successive layers of each material. When bin is full, shovel the materials out (cutting from top to bottom of layers) into hopper of the machine.

Elevator delivers the material into revolving reel, which further mixes and screens it.

The uniformly fine mixture is hoppered to the conveyor, which carries it to the bagging spout.

The lumpy materials which will not pass through the

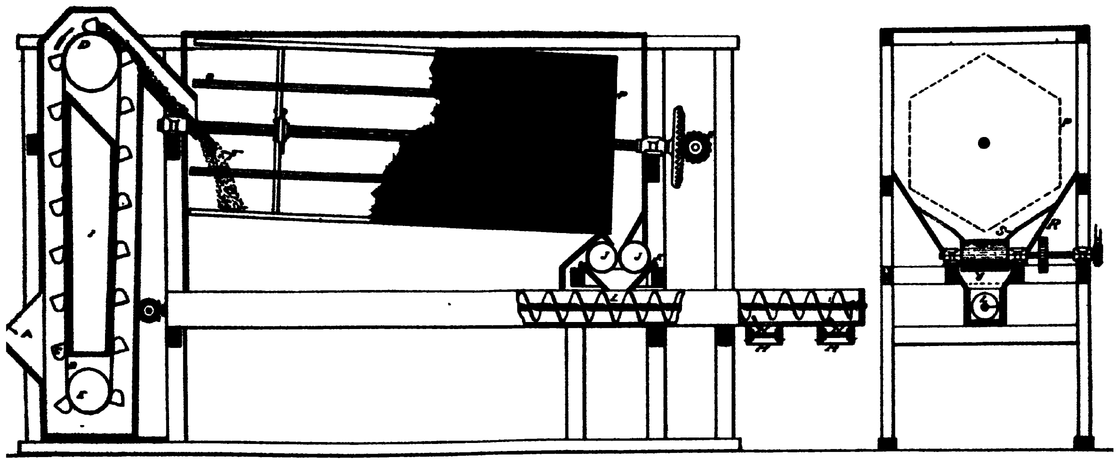


FIG. 124. Fertilizer Mixer.

meshes or perforations, roll out the lower end of screen, and are ground between the rolls, and delivered to the conveyor.

While one bin is being worked out, the other is being weighed full.

These machines will handle two to four tons of fertilizer per hour, according to size of machine, and according to character of the ingredients used. The reel should run about 20 to 30 revolutions per minute. Generally, all of the ingredients are dry, and are ground fine when received. Kainit is the most troublesome of the ordinary ingredients used. It absorbs moisture from the atmosphere, and becomes lumpy in damp weather.

There are other mixing machines, which are designed to do more or less grinding while mixing.

The important difference between mixing fertilizers on the farm for home use, and mixing them in the mill for sale is that in the latter case, the laws require certain guaranteed analysis, or they fix a minimum percentage of phosphoric acid, ammonia and potash. The actual analysis as guaranteed by the mill must be branded on each sack sold. These sacks are occasionally sampled and analyzed, wherever found, by the State inspector. Therefore, it is important that all fertilizer plants should frequently analyze the materials they buy and the goods they sell.

CHAPTER XVI.

The Manufacture of Fertilizers.

The foregoing chapter dealt with the manipulation of certain fertilizer ingredients into definite mixtures, containing known proportions of the fertilizing chemicals. This pre-supposes the existence of these ingredients. The present chapter will discuss the production of some of these ingredients from natural sources of supply.

Raw Materials.

Table XVIII. has shown some of the usual sources from which fertilizer factories secure their raw materials. Nitrogen (or ammonia) is usually taken from cotton seed meal, nitrate of soda, sulphate of ammonia, dried blood, or tankage and fish scrap.

Cotton seed meal is on the market as such. It contains about 7 per cent. nitrogen. Nitrate of soda comes from the nitrate mines of Chili. It is concentrated before shipment, and is about 96 per cent. pure nitrate, equivalent to 16 per cent. nitrogen.

Sulphate of ammonia is a by-product from gas works. It contains about 20 per cent. nitrogen.

Dried blood is obtained from slaughter houses. It contains about 12 per cent. nitrogen (varying from 8 to 16 per cent.).

Tankage is obtained from slaughter houses. It is variable in composition, consisting of all kinds of waste bones, meat and other offal. It contains about 5 per cent. nitrogen.

Fish scrap is the residue from menhaden fish, when they have been pressed for oil. It contains about 8 per cent. nitrogen.

Potash is mostly the product of German mines, generally in the form of sulphate or muriate. Kainit contains about 12 per cent. potash in the form of sulphate. Sylvinit is a

mixture of sulphate and muriate, and contains about 14 per cent potash.

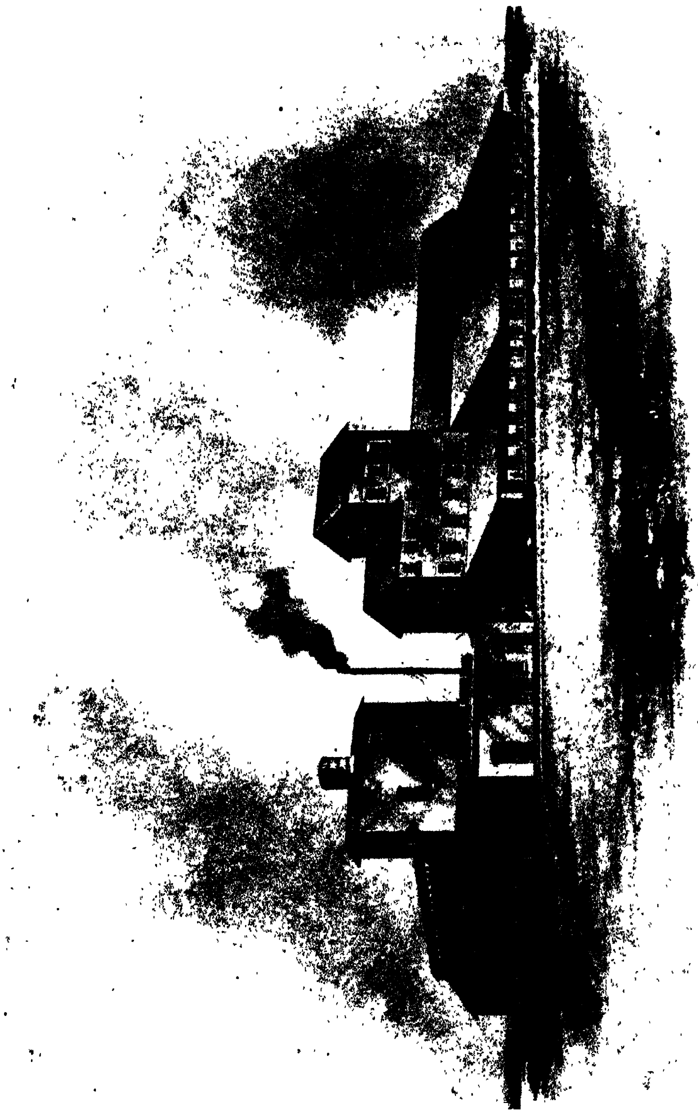
There are some concentrated forms of muriate and sulphate on the market, containing as much as 50 per cent. potash.

The fertilizer factories of the United States do not undertake to manufacture nitrogenous or potassic chemicals, but accept them as raw materials as they appear on the markets. All of the materials mentioned are soluble, and thus available as plant-food. Phosphoric acid, however, occurs in quantity only in an insoluble state. Fertilizer factories undertake to convert these raw materials into products containing phosphoric acid in a condition that may be taken up by plant life.

Phosphoric Acid.

Phosphoric acid is generally referred to as (1) insoluble (that is, insoluble in water and ammonium citrate, though soluble in strong acids), (2) soluble (that is, soluble in water), (3) reverted, which is soluble, in ammonium citrate. The insoluble is of no use to plant life. The soluble is of immediate use; the moisture in the soil dissolves it and carries it to the roots of the plants. The reverted is not soluble in water (it is soluble in ammonium citrate), but may nevertheless be taken up by the roots of plants when they find it. Thus the two last forms are useful, and are generally referred to together as "available." The "available" is all that is of value to the farmer.

Soluble phosphoric acid may be made from raw bones, containing about 20 to 25 per cent. total (soluble and insoluble), of which 5 per cent. is available, or from bone black containing 35 per cent. insoluble. But the common source of supply is phosphate rock. This is mined in South Carolina, containing 25 to 30 per cent. phosphoric acid; in Florida, as land rock phosphate, containing 30 to 35 per cent., or as pebble phosphate, containing 25 to 30; and in Tennessee, containing about 35 per cent.



Fertilizer factories receive this rock in bulk in cars, and grind it into fine powder, and treat it with strong sulphuric acid, thus converting the phosphoric acid into the available form, the product being known as acid phosphate, and sometimes as super-phosphate, containing about 15 per cent. available phosphoric acid. The ground rock is treated with its own weight of sulphuric acid, so that rock containing 30 per cent. would produce a mixture containing only 15 per cent.—omitting a small allowance for evaporation.

Sulphuric Acid.

For the manufacture of acid phosphates, large quantities of sulphuric acid are required. Most of it is water, upon which it is uneconomical to pay freights. It is also dangerous to ship. Therefore most fertilizer companies manufacture sulphuric acid.

Figure 125 is a general view of a complete fertilizer plant, showing the sulphuric acid chamber on the left. Figure 126 is a plan and sectional elevation of the acid chamber. On the left, is the furnace for burning the sulphur or pyrites. The gases pass through one of the towers into the leaden chambers, where they are mostly condensed, the remaining gases being led to and reclaimed in the other tower.

Sulphuric acid may be made from sulphur or from pyrites.

The most profitable material from which to make it must be determined from their respective market prices.

Nearly all of the sulphur is imported from Sicily. Large quantities of pyrites are imported from Spain and Portugal; but it is also largely mined in the United States. There are known good mines in the United States (both sulphur and pyrites) which are not available because of cost of mining or transportation.

Nearly all sulphuric acid chambers, running in connection with fertilizer factories have their furnaces arranged for burning pyrites. Some of them have furnaces for sulphur also, so that they may change from one to the other to suit market changes.

The process of making acid is substantially the same, whether burning sulphur or pyrites, the principal difference being in the construction of the furnaces. The sulphur or pyrites is burned in a suitable furnace. The resulting gases, mostly sulphurous acid gas, pass over heated pots of nitrate of soda, which give off nitrous gases. These gases mingle and pass through the Glover tower into large lead chambers, into which jets of steam are admitted. There are two, and sometimes three, lead chambers, into which the gases successively pass. The first chamber condenses and catches the strongest acid, the ones farthest away make the weakest. The uncondensed gases are conducted back near the starting point to Gay-Lussac tower, where the nitrous gases are partly reclaimed, and the remainder escape.

The chemical reactions taking place in the manufacture of sulphuric acid are complicated.

The result accomplished is that sulphur fumes in the presence of nitrous fumes and steam, all under proper conditions, produce sulphuric acid, which condenses into liquid form. The gases which do not condense in the lead chambers consist mostly of nitrous fumes. These gases are passed to and up the Gay-Lussac tower from the bottom, while strong cool sulphuric acid (60 degrees Baume') is run down from the top. This sulphuric acid absorbs the nitrous gases and saves them for further use. They are separated from the acid by being run down the Glover tower, through which the hot sulphur fumes are passing up from the furnaces.

This contact helps in the production of more sulphuric acid, and makes a complete cycle, in which the nitrous gases are used over and over, without being intentionally consumed. In practice, however, a small amount of the gases are actually condensed with the sulphuric acid, and some escapes into the air, so that it is necessary to constantly supply fresh nitre, in pots in the furnaces.

An ordinary plant for the production of 20 to 25 tons of sulphuric acid per day of 24 hours, would have about

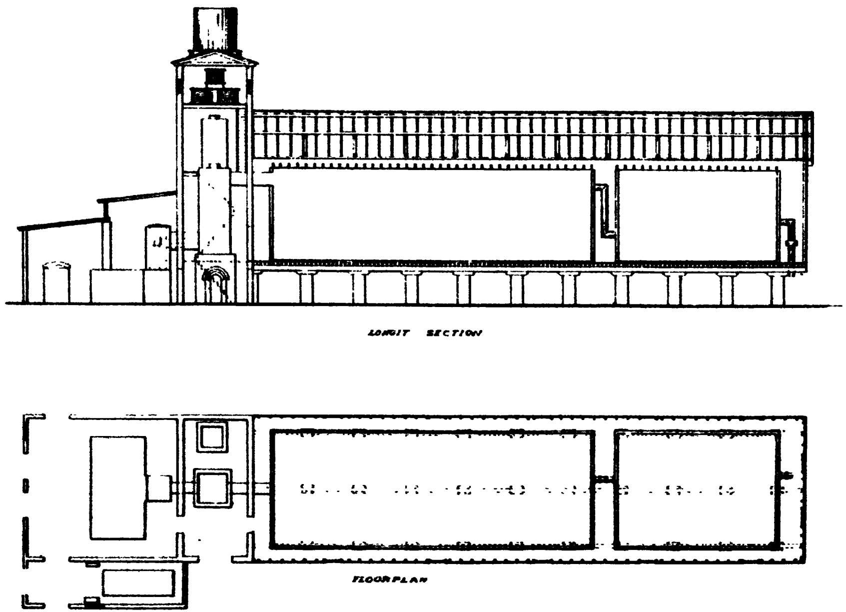


FIG. 126. Plan and Section Sulphuric Acid Chamber.

150,000 cubic feet of lead chambers, say 30 feet wide, 20 feet high, 250 feet long. This is about 7,500 cubic feet of chamber per ton capacity (in 24 hours) of sulphuric acid. This is the lowest allowable limit for good working, and more chamber space would work better. There would be one Glover tower about 9 feet square and 30 feet high, say 2,430 cubic feet, or 120 cubic feet per ton capacity of sulphuric acid. There would be one or two Gay-Lussac towers with total space of about 1,500 cubic feet or 75 cubic feet per ton capacity of acid. If it is in one tower, it might be 7 feet square and 30 feet high, or if two towers, 5 feet square and 30 feet high.

The towers are built of timber, or steel frame, and lined first with sheet lead, and then with hard fire bricks, and finally packed full of quartz rock, for the purpose of making the down-coming acids spread out, and more intimately mix with the up-going gases.

The furnaces would vary according to whether sulphur or lump pyrites or fine dust pyrites are used. The chambers are made by soldering together large sheets of lead in place. This operation is technically known as "lead-burning." The floor of chambers is usually built 4 or 5 feet from the ground, to afford opportunity for detection of leaks. The walls of the chambers are built 4 or 5 feet from the walls of the building, so that there may be free access to every part.

In some improved forms of chambers, there are cooling columns inserted between the successive chambers. These pass the gases around lead tubes, through which air is made to circulate. This assists the chambers in condensing the gases. Sulphuric acid is pumped to the top of the towers, and elsewhere by the use of compresed air. Ordinary forms of pump would be corroded and soon destroyed by the acid. An air compressor forces air into a cast iron drum containing acid (technically known as an "acid egg"). This forces the acid out to the point desired. The pressure is released and more acid admitted, and so on. Sometimes the arrange-

ment is automatic, so that the pumping goes on continuously, without any attention.

The theoretical composition of pure sulphuric acid is by weight as follows:

Hydrogen	2 parts
Sulphur	32 parts
Oxygen	64 parts
	98 parts

Or what is the same thing:

Sulphur	32
Oxygen	48
Water	18
	98

In practice, however, the nearest approach to the above composition contains more water, as follows:

Sulphur	54
Oxygen	64
Water	96
	214

According to this last formula, sulphur forms about 25 per cent. of the weight of the strongest acid. The strength of acid is generally measured by its specific gravity, as determined by a hydrometer. The Baume' hydrometer is the one generally in use in this country. The strong acid above mentioned has a specific gravity of about 1.82, or 66 degrees Baume'. This is known to the trade as "oil of vitriol."

The ordinary acid, as made in the acid chamber for use in making fertilizers, has a specific gravity of 1.5, or 50 degrees Baume'. This strength of acid contains 62½ per cent. of theoretical acid, or about 20 per cent. of sulphur.

According to the above calculations, one pound of sulphur should produce about 5 pounds of 50 degree acid. Owing to the losses in the processes, 4¾ pounds is good practice.

An acid chamber having a capacity of 150,000 cubic feet would burn in a day of 24 hours about 10,000 pounds of sulphur. This would produce about 47,500 pounds of 50 degree acid, or say 24 tons. The cost of operation would be about as follows:

10,000 lbs sulphur @ 1c	$100.00
300 lbs nitrate soda @ 2c	6.00
1½ tons coal @ $3.50	5.25
Labor (6 men)	6.00
Superintendence	3.00
Insurance and incidentals	4.00
Total cost of 24 tons acid	$124.25

Cost per ton about $5.20.

When using pyrites instead of sulphur, the cost may generally be reduced. Ordinary American pyrites contains about 42 per cent. of actual sulphur, but only about 40 per cent. can be utilized.

In order to make the same 24 tons of acid, it will require the same 10,000 pounds of sulphur, and this requires 25,000 pounds of pyrites, or say 11 long tons. The cost of operation would be about as follows:

11 long tons pyrites @ $5.00	$55.00
300 lbs. nitrate soda @ 2c	6.00
2 tons coal @ $3.50	7.00
Labor (8 men)	8.00
Superintendence	3.00
Insurance and incidentals	4.50
Total cost of 24 tons acid	$83.50

Cost per ton about $3.50.

The cost of acid chambers of the capacity above mentioned is for burning sulphur about $25,000, and for burning pyrites about $30,000.

Figure 126 shows plan and elevation of a set of sulphuric acid chambers.

Making Acid Phosphate.

Fig. 127 shows the general arrangement of machinery for grinding phosphate rock and treating it with sulphuric acid for the production of the acid phosphate of commerce.

Fertilizer Plant, Fig. 127—Lettering.

A.—Phosphate rock unloaded from cars.
B.—Rock crusher.
C.—Elevator.
D.—Bins for crushed rock.
E.—Spouts to grinding mills.
F.—Grinding mills.
G.—Conveyor.
H.—Elevator to ground rock bins.
J.—Ground rock bins.
K.—Mixing machine.
L.—Sulphuric acid tank.
M.—Car to carry away mixed material dumped from mixing machine.

Process.

Rock is crushed small enough for the grinding mills to receive it.

Crushed rock is elevated to bins, to be fed to mills.

Mills grind rock to fine powder.

The ground rock is stored in bins at top of tower, ready for mixing.

Ground rock is weighed into mixing machine.

Sulphuric acid is weighed into mixing machine, about same weight as the ground rock.

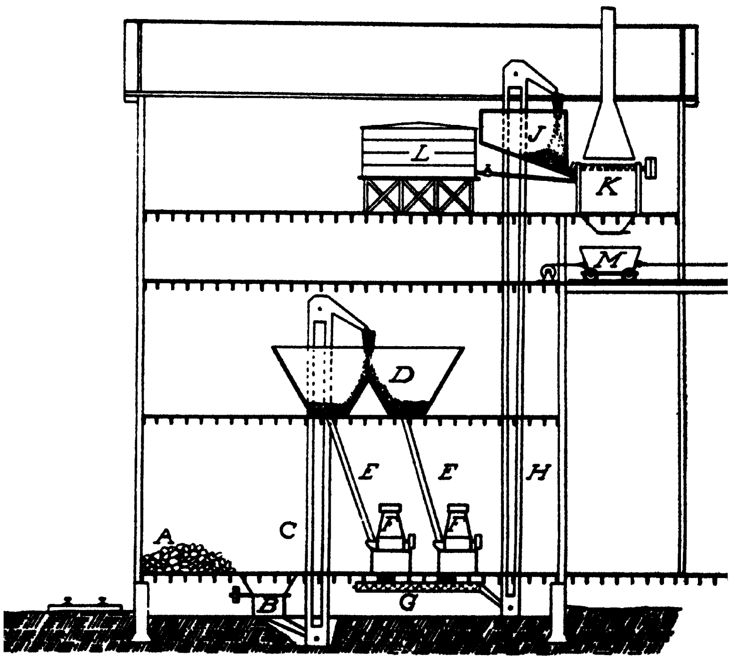


FIG. 127. Fertilizer Factory.

Mixing machine stirs them intimately together. Heat and fumes are generated.

When mixing is complete, material is dumped into a car running on track to the desired spot in the shed, where it is automatically dumped.

Material remains in the dump shed and dries until ready to be sacked.

Sacking is accomplished in a machine similar to the fertilizer mixer, Fig. 124.

Finished Fertilizers.

Mixed or "manipulated" fertilizers of any desired formula may be made according to the process described in the last chapter.

There is another style of mixing that can only be done in a plant where the acid phosphate is actually made. This is known as the "wet mix." Instead of waiting for the acid phosphate to dry and be sacked for mixture with the potash- and ammonia-producing chemicals, these chemicals are elevated to the top of the building into bins near the ground rock bins. When the ground rock is run into the mixer and treated with sulphuric acid, then the ammonia chemicals are added, and finally the potash, and they are all mixed at once, thus being perfectly blended. The product is then run into the car and dumped, as in the case of plain acid phosphate.

In making wet mixtures, nitrate of soda should never be used, because in presence of sulphuric acid, nitrogen escapes. Even in dry mixing, it is not well to use nitrate of soda, because in standing, there is loss of nitrogen, but all other sources of nitrogen may be freely used.

Wet mixed fertilizers are much more uniform in analysis than the dry mixed.

A fertilizer factory of this description of sufficient capacity to use the 24 tons of acid in 24 hours, made by the acid chamber described, would use 24 tons of rock, and make about 45 tons of commercial acid phosphate.

If the whole product is turned into ammoniated guano, it would make about 75 tons.

The cost of such a fertilizer factory would be about $25,000. The whole cost of fertilizer factory and acid chamber for burning pyrites would be $60,000 to $75,000.

The result of the operations of the entire plant for one day of 24 hours, making ammoniated fertilizer, would be about as follows:

Sulphuric acid, 24 tons @ $4.50	$108.00
Phosphate rock, 24 tons @ $6.00	144.00
Cotton seed meal, 22½ tons @ $18.00	405.00
Kainit, 7½ tons @ $10.00	75.00
6 tons coal @ $3.50	21.00
Sacks	60.00
Labor (20 men)	20.00
Superintendence	3.00
Insurance and sundries	10.00
Total cost 75 tons of fertilizer	$846.00

This is about $11.30 per ton. In the above table the sulphuric acid is put in at the cost of manufacture, as shown in a former table.

Ammoniated fertilizers usually cost the farmer $20 to $25 per ton. The great difference between manufacturing cost, and the cost to consumer is not by any means all profit to the manufacturer. He usually sells to a wholesale dealer, who sometimes guarantees to sell the entire output. These in turn sell to retail dealers, who sell to the farmer, very often on long credit. Thus the apparent profit is divided between the manufacturer and at least two middlemen, besides being reduced by interest on the long credit, and by bad debts.

Cotton Option.

Sometimes fertilizers are sold to farmers on what is known as the "cotton option" plan. The farmer buys the fertilizer

in the spring, payable the next fall, either at a stated price. say $25.00 per ton, or for say 300 pounds of lint cotton, regardless of the price. The farmer has the option. He would, of course, pay in cotton instead of money, in case the price of cotton should happen to be (on the arrangement above stated), less than 8 1-3 cents per pound at the specified date of settlement. This is in the nature of a speculation; but it is a safe one for the farmer, and may be made safe for the fertilizer man if he fixes the option equivalent at such a price that it may be covered by the sale of cotton "futures."

APPENDIX.

Containing Documents Relating to the Early History of the *Saw* Gin, and Notes and Tables Relating to Cattle Feeding.

Document I.

List of Suits for Infringement and Damages Brought by Whitney in United States District Court, Savannah, Ga.

Edward Lyons, 1795, non-suit, 1798.

Wm. Kennedy & Co., 1795, verdict for defendant.

Fred Ballard, 1798, non-suit, 1799.

McKinney & Co., 1801, dismissed, 1804.

William Clark, 1801, non-suit, 1803.

John Morrison, 1801, defendant dead.

William Byrnes, 1801, non-suit, 1803.

John Walker, 1801, non-suit, 1804.

Chas. Gachet, 1801, non-suit, 1803.

Isaiah Carter, 1801, non-suit, 1803.

Wm. Few, 1801, verdict for defendant.

John Davis, 1801, non-suit, 1803.

Sam'l Devereux, 1801, not served.

Solomon Marshall, 1801, settled.

Arthur Fort, 1801, not served.

James Moore, 1801, not served.

Ignatius Few, 1801, not served.

Sam'l Higginbotham, 1801, non-suit, 1803.

Jonathan Embree, 1801, non-suit, 1803.

Henry Keebler, 1801, non-suit, 1803.

D. W. Easley, 1801, non-suit, 1803.

Silus Grigg, 1801, not found.

Arthur Fort, 1801, non-suit, 1803.

Arthur Fort and John Powell, 1804, decree for perpetual injunction, Dec. 19th, 1806.

Chas. Gachet, 1806, verdict for $1,-500, May 11th, 1808.

Isaiah Carter, 1806, verdict for $2,-000, May 10th, 1808.

Wm. Byrnes, 1807, judgment by default, 1811.

Document II.

WHITNEY'S SPIKE GIN PATENT.

Certified Copy of the Original Patent Specif cations filed in the Patent Office by Eli Whitney, 1793-4.

This paper is now on file in the United States Court House, Savannah, Ga.

(NOTE.—Corresponding clause occurs at the end of this paper.)

Document III.

THE WHITNEY SUBSTITUTED PATENT PAPERS.

Copy of Specifications filed with the Patent Office in 1841, After the Fire. This Purports to be a Reproduction of the Original Papers. It is Printed in Parallel Column, so it May be Compared With the Authentic Copy.

This paper is now on file in the Patent Office at Washington.

UNITED STATES OF AMERICA.

To all to whom these Letters Patent shall come:

WHEREAS, Eli Whitney, a citizen of the United States, hath alleged that he has invented a new and useful improvement in the mode of spinning cotton, which improvement he states has not been known or used before his application; hath made oath that he does verily believe that he is the true inventor or discoverer of the said improvement; hath paid into the Treasury of the United States the sum of thirty dollars, delivered a receipt for the same, and presented a petition to the Secretary of State, signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted: THESE ARE THEREFORE to grant, according to law, to the said Eli Whitney, his heirs, administrators or assigns, for the term of fourteen years from the sixth day of November last, the full and exclusive right and liberty of making, constructing, using, vending to others to be used, the said improvements; a description

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whereof is given in the words of the said Eli Whitney, himself, in the schedule hereto annexed, and is made a part of these presents.

In testimony whereof I have caused these Letters to be made Patent, and the Seal of the United States to be hereunto affixed.

GIVEN under my hand, at the City of Philadelphia, this fourteenth day of March, in the year of our Lord one thousand, seven hundred and ninety-four, and of the Independence of the United States of America the eighteenth.

(Seal.)

G. WASHINGTON.
EDM. RANDOLPH,
Secretary of State.

City of Philadelphia, to-wit:

I do certify that the foregoing Letters Patent were delivered to me on the fourteenth day of March, in the year of our Lord one thousand, seven hundred and ninety-four, to be examined; that I have examined the same, and find them conformable to law; and I do hereby return the same to the Secretary of State within fifteen days from the date aforesaid, to-wit, on this fourteenth day of March, in the year aforesaid.

WM. BRADFORD,
Attorney General of the United States.

The schedule referred to in these letters patent and making part of the same, containing a description in the words of the said Eli Whitney himself

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A description of a new invented cotton gin, or machine for cleansing and separating cotton from its seeds.|

This machine may be described under five divisions, corresponding to its five principal parts, viz: 1. Frame. 2. The Cylinder. 3. The Breastwork. 4. The Cleaner. 5. The Hopper.

1. The frame, by which the whole work is supported and kept together, ought to be made of well seasoned timber, so that it may be firm and steady, and never become loose in the joints. Scantling four inches by three, will perhaps be stuff, of as suitable size as any. The frame should be of a square or parallelogramic form, the width must answer to the length of the cylinder and the height and length may be proportioned as circumstances shall render convenient.

In the drawing annexed, Fig. 1, is a section of the machine. A represents the cylinder, B the breastwork, C the cleaner and D the hopper.

2. The cylinder is of wood; its form is perfectly described by its name, and its dimensions may be from six to nine inches diameter, and from two to five feet in length. This cylender-cylender is placed horizontally across the frame, in such manner as to give room for the clearer on one side of it, and the hopper on the other as in Fig. 1. Its height, if the machine is worked by hand should be about three feet four inches; otherwise it may be regulated by conven-

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of an improvement in the mode of ginning cotton.

A short description of the machine invented by the subscriber for ginning cotton.

The principal parts of this machine are 1st, the frame; 2d, the cylinder; 3d, the breastwork; 4th, the clearer and 5th, the hopper.

1st. The frame by which the whole work is supported and kept together, is of a square or parallelogramic form and proportioned to the other parts as may be most convenient.

2d. The cylinder is of wood, its form is perfectly described by its name, and its dimensions may be from six to nine inches diameter, and from two to five feet in length. The cylinder is placed horizontally across the frame, leaving room for the clearer on one side, and the hopper on the other. In the cyl-

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lence. In the cylender is fixed an iron axis so large as to turn in the lathe without quivering. The axis may pass quite through the cylender or consist only of gudgeons, driven with cement in each end. There must be a shoulder at C, Fig. 2, on each side the bearing or box to prevent any horizontal variation in the cylinder. The bearings of the axis or those parts which rest on the boxes must be rounded in a lathe, so that the centre of the axis may coincide with the centre of the cylender. One end of the axis should extend so far without the frame as to admit the winch, by which it is turned, to be connected with it at C, and so far at the other end as to receive the whirl designed for putting the clearer in motion. The brass boxes, in which the axis of the cylender runs, consist each of two parts, C and D, Fig. 7. The lower part, D, is sunk into the wood of the frame to keep it firm and motionless and the upper part, C, is kept in its place by two small iron-iron bolts, HH, headed on the lowerend at H. These boits are inserted into the under side of the rail or scantling of the frame and continued up through both parts of the box. A portion of the bolts as H, A, should be square, to prevent them from turning. The upper part of the box, C, is screwed down close with a nut on the end of each bolt. At E, is a perforation for conveying oil to the axis. After the cylinder with its axis is fitted and rounded with exactness, the circular

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inder is fixed an iron axis which may pass quite through, or consists only of gudgeons driven into each end.

There are shoulders on this axis, to prevent any horizontal variation, and it

extends so far without the frame as to admit a winch at one end, by which it is put in motion, and so far at the other end as to receive the whirl by which the clearer is turned. The sur-

face of the cylinder is filled with teeth,

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part of its surface is filled with teeth set in annular rows. The spaces D, E, F, G, H, Fig. 2, between the rows of teeth must be so large as to admit a cotton seed to turn around freely in them every way, and ought not to be less than seven-sixteenths of one inch.	set in annular rows, which are at such a distance from each other as to admit a cotton seed to play freely in the space between them. The space be-
The spaces K, L, M, N, &c, Fig 1, between the teeth, in the same row, must be so small as not to admit a seed or a half seed. They ought not to exceed one-twelfth of an inch; and I think about one-sixteenth of an inch the best. The teeth are made and set in the following manner:	tween each tooth in the same row, is so small as not to admit a seed, nor a half seed to enter it. These teeth are
Take common iron wire, about No. 12, 13 or 14, draw it about three sizes less, without nealing in order to stiffen it. Cut it into pieces four or five feet in length and straighten them. Steel wire would perhaps be best if it were not too expensive.	made of stiff iron wire, driven into the wood of the cylinder. The teeth are
Then with a machine, somewhat like that used for cutting nails, cut the wire into pieces about one inch long. In the jaws of this machine at O, Fig. 10, are fixed the two pieces of steel D, D, which are pressed together, as may be observed from the figure, by the operation of a compound lever. These pieces of steel are so set in, that upon being pressed together, their approaching surfaces, meet only on one side next to D, D, leaving between them a wedge like opening, which enlarges as the distance from the place of contact increases. On the side, D, D, about one inch distant from the place of contact, is fixed a guage. The wire is inserted on the side opposite D, D, and thrust thro' to the	

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guage. Then on forcing down the lever the wire is separated, leaving that end of the wire next the side D, D, cut smoothly and transversely off, and the end of the other part flattened like a wedge. The fattened end is then thrust forward to the guage and the same operation is repeated. In this manner the teeth are cut of equal length, with one end flattened and the other cut directly off. Flatting one end of the wire is beneficial in two ways: 1. The flatted ends of the teeth are driven into the wood with more ease and exactness. 2. It prevents them from turning-turning after they are set. To prevent the wires from bending while driving, they are holden with pliers the jaws of which ought to be about half an inch in width, with a corresponding transverse groove in each jaw. Thus holden, the teeth are, with a light hammer driven, one by one, into the cylender, perpendicularly to its axis. Then with a tool, like a chisel or common screw driver each tooth is inclined directly towards the tangent to that point of the circle, into which it is set, till the inclination is such that the tooth and tangent form an angle of about 55 or 60 degrees. If this inclination be greater, the teeth will not take sufficient hold of the cotton, if it be less there will be more difficutly in disengaging the cotton from the teeth, after it is separated from the seeds.

When the teeth are all set they should be cut of an equal length. In order for this, take a crooked guage, Fig. 8,

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all inclined the same way and in such a manner, that the angle included between the tooth and a tangent drawn from a point into which the tooth is driven, will be about 55 or 60 degrees. The gudgeons of the cylinder run in brass boxes, each of which is in two parts, one of which is fixed in the wood of the frame and the other is confined down upon the axis with screws.

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having two prongs, Q, R, the curvature of which corresponds with that of the cylinder. This guage is merely a crooked fork, the thickness of whose prongs or tines, as represented between S and T, Fig. 9, equalizes the length of the teeth, and is applied to the cylinder, with one tine on each side of an annular row. With a pair of cutting pliers, cut the teeth 1, 2, 3 and 6, off even with the guage, then slide italong to 6, 7, 8, &c., and so proceed till you have trimmed all the teeth to an equal length. This done put the cylender into a lathe and with a file bring the teeth to a kind of angular point, resembling a wire flatted and cut obliquely. After the teeth are brought to a proper shape, smooth them with a polishing file and the cylender will be finished.

Remark. Though the dimensions of the cylender may be varied at pleasure, yet it is thought that those described are the best, being more easily made and kept in repair, than those of a larger size. The timber should be quarter stuff, i. e., a quarter of the trunk of the tree, otherwise it will crack in seasoning. It must also be of wood of an equal density, such as beech, maple, black birch, &c. In oak and many other kinds of wood, there are spaces between the grains which are not so hard as the grains themselves; and the teeth driven into these spaces would not stand sufficiently firm, while the grains are so hard as to prevent the teeth from being driven without bending.

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3. The breastwork, Fig. 2, and B, Fig. 1 and Fig. 2, is fixed above the cylender parallel and contiguous to the same. It has transverse grooves or openings 1, 2, 3, 4, &c., through which the rows-rows of teeth pass as the cylender revolves: and its use is to obstruct the seeds while the cotton is carried forward through the grooves by the teeth. That side of the breastwork next the cylinder should be made of brass or iron, that it may be the more durable. Its face or surface A, X, Fig. 1, ought to make an angle with the tangent X, Z, less than 50 degrees. A tooth in passing from K up to the breastwork B, fastens itself upon a certain quantity of cotton, which is still connected with its seeds. The seeds being too large to pass through the breastwork are there stopped, while the cotton is forced thro' the groove and disengaged from the seeds. Now if the point of the tooth enters the groove before the root, or that part next the cylinder it carries through all which it has collected in coming from K; but if the root of the tooth enter the groove before the point, part of the cotton fastened on it, will slide off, and this latter case is preferable as it helps to give the cotton a rotary motion in the hopper. The thickness of the breastwork, or the distance from A to I, Fig. 1, should be about 2½ or 3 inches, in proportion to the length of the cotton. It should be such that the cotton which is carried through by the teeth may be discon-

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3d. The breastwork is fixed above the cylinder, parallel and contiguous to the same. It has transverse grooves or openings through which the rows of teeth pass as the cylinder revolves and its use is to obstruct the seeds while the cotton is carried forward through the grooves by the teeth. The thickness of the breastwork is two and half or three inches and the under side of it is made of iron or brass.

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nected from-from that which is left in the hopper, before it leaves the grooves, otherwise that which is carried partly through the breastwork will be by the motion of that with which it is connected in the hopper become so collected and knotted at I, as to obstruct and bend the teeth.**

The under part of the breastwork next the cylender, ought, as has before been observed, to be made of iron or brass. It may be cast either in a solid piece and the openings for the passage of the teeth cut with a saw and files, or in as many parts as there are spaces between the several rows of teeth in the cylender and in form of Fig. 12, and the pieces set, by means of a shank or tenon, in a groove running lengthwise along the wooden part of the breastwork.

The breastwork described, if properly constructed, will it is thought answer every valuable purpose. But I shall mention one of a different construction which I have used with success, and is made in the following manner:

Form a breastwork of the same shape and dimensions as the one before described, entirely of wood. Place a bar of wood one inch below the cylender and parallel to it, then with straps or ribs of iron, brass or tin plate connect the breastwork of-of wood with the bar below.

**If the perforation about 3-16 of an inch be made through the breastwork at the upper part or end of each groove, the metal part need not be more than ⅜ of an inch thick.

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The ribs or straps must be so applied as to sit close to the surface of the cylender between the wooden breastwork and the bar, and if of a width that will permit them to work freely between the annular rows of teeth. That end of each strap which is fastened to the breastwork should divide widthwise into two parts, one of which should pass along the lower surface of the breastwork, and the other run up its front. In Fig. 14, B, is the wooden breastwork. D, the bar below the cylender, the dotted circle B, B, the cylender E, E, the strap C, the place where the strap divides, and A, A, A, wood screws or nails with which the strap is made fast to the bar and breastwork.

4. The clearer C, Fig. 1, is constructed in the following manner: Take an iron axis perfectly similar to that described as extending through the cylender, except that it need not be so large nor fitted for the application of a winch. Frame together crosswise at right angles two pieces of timber of suitable size and of a length about equal to the diameter of the cylenders, so as to make the four arms equal in length, and insert the axis through the centers of two crosses or frames of this kind. Let their distance from each other be one-third of the length of the cylender and make them fast on the axis. The arms of the two crosses are then connected by four pieces, of the same length of the cylender, equidistant from the axis, and parallel to the same, and to each other. In each

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4th. The clearer is placed horizontal with and parallel to the cylinder. Its length is the same as that of the cylinder, and its diameter is proportioned by convenience. There are two, four or more brushes or rows of bristles, fixed in the surface of the clearer in such a manner that the ends of the bristles will sweep the surface of the cylinder.

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of the parallel pieces, on the outside or side opposite the axis, a channel is made lengthwise for the reception of a brush. The brush is made of hog's bristles, set in a manner somewhat similar to that of setting the reeds in a weaver's sleigh. Between two strips of wood about ⅛ of an inch in thickness and half an inch in breadth, is placed a small quantity of bristles, then a strong thread or twine is wound round the sticks, close to the bristles, then another quantity of bristles is inserted, etc., till a brush is formed, equal in length to the cylender.*

The bristles on the side A, A, Fig. 6, are smeared with pitch or rosin and seared down with a hot iron even with the wood, to prevent them from drawing out. On the other side they are cut with a chisel to the length of about one inch from the wood. A brush of this kind is fixed in each of the before mentioned channels.

The boxes as well as axis of the clearer, are like those of the cylender, parallel to it and at such a distance, that while it revolves the ends of the bristles strike with a small degree of friction on the cylender's surface. Its use is to brush the cotton from the teeth after it is forced through the grooves and separates from its seeds. It turns in a direction contrary from that of the cylender, and should so far

*(Perhaps nailing these straps together would be better than winding them with twine.)

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Its axis and boxes are similar to those of the cylinder. It is turned by means of a band and whirls, moves in

a contrary direction from the cylinder by which it is put in motion, and so

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outrun it, as completely to sweep its whole surface.*

A clearer with two brushes may be made by simply screwing upon the axis the board K, Fig. 4, and another similar board on the opposite side, which leave spaces for the insertion of the brushes, S, S. The cleaner may be also formed of a cylender with grooves running lengthwise in it for the reception of the brushes; or in any other way, which may be found convenient.

The number of brushes in the clearer is not material; but let it be observed that the distance from E to E, Fig. 1, between the brushes, must be at least 4 or 5 inches, otherwise the cotton will wind up 'round the clearer. The surface of the clearer moving much faster than that of the cylender, the brushes sweep off the cotton-cotton from the teeth. The air put in motion by the clearer, and the centrifugal force of the cotton disengage it from the brushes. Note. It is best to set the brushes in the grooves in such a manner, that the bristles will make an angle of about 20 or 25 degrees, with the diameter of the clearer, in the direction E, O, Fig. 1. By that means the bristles fall more perpendicularly on the teeth, strike them more forcibly, and clear off the cotton more effectually.

The clearer is put in motion by the cylender, by means of a band and

*(The brushes may be fixed in a stock which is movable by screws so as to bring them nearer or carry them farther from the cylender.)

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far outruns it, as to sweep the cotton from the teeth as fast as it is carried through the breastwork. The periphery of the whirls is spherical and the band a broad strap of leather.

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whirls. These whirls are plain wheels of solid wood, about 2½ or 3 inches thick, their periphery is a spherical surface swelling at the centre, and and sloping off at the edges. To give them a proper shape, take a perfect globe of the same diameter as your intended whirl; inscribe upon it a circle dividing it into two equal parts; then cut the globe on each side, parallel to the plane of the circle, and at the distance from it, of half the thickness of your whirl. On these whirls runs a leather band, the breadth of which answers to the thickness of the whirls. The band may be broader or narrower and the whirls thicker or thinner in proportion as the resistance to be overcome is greater or less. The reason for giving-giving the whirls this shape is to secure them the better from being unbanded. A band of this kind always inclines to the highest place on the whirl, and is much less liable to be cast off from the work, when it runs on a special surface, than when it runs in a groove in the periphery of the whirl.

The whirls are four in number and must be so arranged as to make their central planes coincident. The whirl E, Fig. 3 is fixed upon the end of the axis of the cylender without the frame, and the button A, Fig. 5, is screwed on with the screw driver, B, to keep the whirl in its place. L is put upon the axis of the clearer in the same manner. P, Q, whose axes are pivots made fast in the frame, are false whirls added for two purposes. 1. To

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make the clearer turn in a contrary direction from the cylender. 2. For the purpose of doubling the band more completely round the small whirl L, so as to bring a greater portion of the whirl's surface into contact with the band, increase the friction and consequently turn the whirl more forcibly. The first of these purposes might be accomplished by the addition of one false whirl, but the second not so fully without two. The dotted line W, V, represents the band. The diameters of the whirls E, L, should be so-so proportioned as to produce a proper degree of velocity in the clearer. The axis of the whirl Q, is fixed in a plate of iron, which is movable in a groove in the side of the frame and the band is made tighter or looser by moving the plate. This arrangement of whirls produces the same movement as a cog wheel and pinion, with much less friction and expence, and without the ratling noise, which is always caused by the quick motion of cog wheels.

5. One side of the hopper is formed by the breastwork, the two ends by the frame, and the other side is movable so that, as the quantity of cotton put in at one time decreases, it may slide up nearer the cylinder, and make the hopper narrower. This is necessary in order to give the seeds a rotary motion in the hopper, by bringing them repeatedly up to the cylinder till they are entirely stripped of the cotton. D, Fig. 1, is a section of the movable part of the hopper. The part from H to I should be concave on the side next the

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5th. One side of the hopper is formed by the breastwork, the two ends by the frame, and the other side is movable from and towards the breastwork, so as to make the hopper more or less capacious.

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breastwork, or rather it should be a portion of a hollow cylender. Between H and Y, is a crate of wire through which the sand, and the seeds as soon as they are thoroughly cleansed, fall into a receptacle below. The crate may be either fixed in the-the frame or connected with the movable part of the hopper. The wires of which the crate is made should be large and placed perpendicular to the cylender, that the cotton may turn the more easily in the hopper.

A few additional remarks will sufficiently shew the construction, use and operation of this machine. The cotton is put in the hopper, I, D, H, K, A, U, S, Fig 1, in as large a quantity as the cylinder will put in motion. Some of the seeds become stripped sooner than others. If it be black seed cotton, the seeds become smooth, will most of them fall through the crate as soon as they are clean, but a considerable part of the green seeds which they are thus denominated from being covered with a kind of green coat, resembling velvet will continue in the hopper. It will not answer therefor to supply it gradually as the quantity in it diminishes, because the seeds will soon grow cumbrous and by their constant intervention prevent the teeth from attaching themselves to the cotton so fast as they otherwise would, but one hopper full must be finished, the movable part drawn back, the hopper cleared of seeds and then supplied with cotton anew.

There is a partition Y, W, under the

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The cotton is put into the hopper, carried thro' the breastwork by the teeth, brushed off from the teeth by the clearer and flies off from the clearer, with the assistance of the air, by its own centrifugal force. The ma-

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cylender on the left-left hand of which or the side beneath the hopper, the seeds fall, and the clean cotton on the other side. There may be a receptacle for the clean cotton in the frame, but it is best to have an opening through the wall or partition into a contiguary room, then place the end of the machine against this opening and let the cotton fly into a close room; or it may fall through an opening in the floor into a room below.

This machine may be turned by horses or water with the greatest ease. It requires no other attendance, than putting the cotton into the hopper with a basket or fork, narrowing the hopper when necessary and letting out the seeds after they are clean. One of its peculiar excellencies is, that it cleanses the kind called green seed cotton almost as fast as the black seed. If the machinery is moved by water it is thought it will diminish the usual labor of cleaning the green seed cotton at least forty-nine fiftieths.

The foregoing is a description of the machine for cleansing cotton alluded to in a petition of the subscriber, dated Philadelphia, June 20th, 1793, and lodged in the office of the Secretary of State, all alleging that he, the subscriber, is the inventor of said ma-

SUBSTITUTED PATENT.

chine is turned by water, horses or in any other way as is most convenient.

There are several modes of making the various parts of this machine, which together with their particular shape and formation are pointed out and explained in a description with drawings, attested as the act directs and lodged in the office of the Secre-

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chine, and signifying his desire of obtaining an exclusive property in the same. ELI WHITNEY.

Signed in presence of

CHAUNCEY GOODRICH,
Counsellor at Law, Hartford.

JOHN ALLEN,
Counsellor at Law, Litchfield.

State of Connecticut, ss. City of New Haven.

I, Elizur Goodrich, Esq., Alderman for said City, and Notary Public, by lawful authority admitted and sworn, residing in said City, and by law authorized to administer oaths, do hereby certify, declare and make known to whom it doth or may concern: That at said City on the twenty-eighth day of October, one thousand, seven hundred and ninety-three, Eli Whitney, of the county of Worcester, in the commonwealth of Massachusetts, now residing in said City, personally appeared before me, the said Alderman and Notary, and made solemn oath, that he does verily believe that he the said Whitney, is the true inventor and discoverer of the machine for ginning cotton, a description whereof is hereto annexed by-by me, the said Alderman and Notary, by my seal Notarial, and that he, the said Whitney, verily believes that a machine of similar construction hath never before been known or used.

In testimony whereof, I, the said Alderman and Notary, have hereunto set my hand and seal at the

SUBSTITUTED PATENT.

tary of State. ELI WHITNEY.

Signed in presence of

CHAUNCEY GOODRICH,
Counsellor at Law, Hartford.

JOHN ALLEN,
Counsellor at Law, Litchfield.

(Received and recorded May 2, 1841, and Ex'd W. G. C.)

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city aforesaid on the day above said.

(L.S.) ELIZUR GOODRICH,
Alderman and Notary Public.

UNITED STATES OF AMERICA.

To all to whom these Letters Patent shall come:

Whereas, Eli Whitney, a citizen of the State of Massachusetts, in the United States hath alleged that he has invented a new and useful improvement in the mode of ginning cotton, which improvement has not been known or used before his application, has made oath, that he does verily believe that he is the true inventor or discoverer of the said improvement, has paid into the Treasury of the United States, the sum of thirty dollars, delivered a receipt for the same and presented a petition to the Secretary of State, signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted for that purpose: These are therefore, to grant according to law, to the said Eli Whitney, his heirs, administrators or assigns, for the term of fourteen years, from the sixth day of November last, the full and exclusive right and liberty of making, constructing, using and vending to others to be used the said improvement, a description whereof is given in the words of the said Eli Whitney, himself, in the schedule-schedule hereto annexed and is made a part of these presents.

In testimony whereof, I have

SUBSTITUTED PATENT.

(NOTE.—Corresponding clause occurs at the beginning of this paper.)

ORIGINAL PATENT.

caused the letters to be made patent and the Seal of the United States to be hereunto affixed.

Given under my hand at the city of Philadelphia, this fourteenth day of March, in the year of our Lord, one thousand, seven hundred and ninety-four, and of the Independence of the United States of America, the eighteenth.

(L. S.) GEO. WASHINGTON.

By the President.

EDM. RANDOLPH.

City of Philadelphia, to-wit:

I do hereby certify that the foregoing Letters Patent were delivered to me on the fourteenth day of March, in the year of our Lord, one thousand, seven hundred and ninety-four, to be examined. That I have examined the same, and find them comformable to law. And I do hereby return the same to the Secretary of State, within fifteen days from the date aforesaid, to-wit: On this same fourteenth day of March, in the year aforesaid.

WM. BRADFORD.

Attorney General, United States.

The schedule referred to in these Letters Patent and making part of the same containing a description in the words of the said Eli Whitney himself of an improvement in the mode of ginning cotton.

Document IV.

In Reply Please Refer to
C. W. K. Letter No. 8348.
All communications should
be addressed to
"The Commissioner of Patents, Washington, D. C.
Department of the Interior,

UNITED STATES PATENT OFFICE,
Washington, D. C., January 18, 1901.

Mr. D. A. Tompkins,
United States Industrial Commission,
Bliss Building, Washington, D. C.

Sir:—Your letter of the 14th instant has been received, and in reply thereto the Commissioner directs me to say that on December 15, 1836, a fire destroyed the building in which the Patent Office was, with all the models and records and the library. By an act of March 3, 1837, provision was made to restore the specifications, drawings and models, by obtaining duplicates of them from the persons possessing the originals, for which purpose an appropriation of $100,000 was made. The whole number of models destroyed was about 7,000, and the records covered about 10,000 inventions. The work of restoration continued for twelve years, and $88,237.32 was expended out of the amount allowed.

On September 24, 1877, the roof and model rooms and contents in the west and north wings of the building were destroyed by fire. About 87,000 models and 600,000 copies of drawings were ruined by fire and water. A full account of this fire was published in the Official Gazette of the Patent Office on October 9, 1877.

Very respectfully,
E. V. SHEPARD, Chief Clerk.

Document V.

CERTIFIED COPY OF BILL OF INJUNCTION AGAINST FORT & POWELL FOR INFRINGEMENT OF GIN PATENT.

This paper is now on file in the United States Court House, Savannah, Ga.

To the honorable, the judges of the Circuit Court of the United States for the district of Georgia:

Humbly complaining shew unto your honors your orators, Eli Whitney, of the State of Connecticut, and Catharine Miller, and Lemuel Kollock, executors of the last will and testament of Phineas Miller, deceased, all citizens of the United States: That by virtue of an act of the Congress of the United States entitled an act to promote the progress of useful arts, and to repeal the act heretofore made for that purpose, passed the twenty-first day of February, in the year of our Lord, one thousand, seven hundred and ninety-three, letters patent were issued in the name of the United States, and bearing test by the president, thereof, on the fourteenth day of February, in the year of our Lord, one thousand, seven hundred and ninety-four, whereby the United States of America did grant unto your orator, Eli Whitney, his heirs, administrators, and assigns, for the term of fourteen years, from the sixth of November, in the year of our Lord, one thousand, seven hundred and ninety-three, the full and exclusive right, and liberty of making, constructing, using and vending to others to be used, a certain new and useful improvement in the art of ginning cotton, which improvement had not before been known or used, whereof your orator, Eli Whitney, was the original inventor, the principle of which invention consists in the art of extracting the cotton from the seed by

means of teeth composed of metal, which teeth are attached to a cylender, on which they revolve, passing through grooves, or openings of a breastwork too narrow to admit the seed, through which grooves the cotton is carried by the teeth and after passing through is brushed off from the teeth by a clearer or brush; as by the said letters patent under the great seal of the United States, bearing date the said fourteenth day of March, seventeen hundred and ninety-four, (a copy whereof is exhibit A, which your orator prays may be taken a part of this bill) will more fully appear.

And your orators further shew that on the twenty-first day-day of June, in the year of our Lord, one thousand, seven hundred and ninety-four, one of your orators, Eli Whitney, being so possessed of, and entitled, to the exclusive right above set forth, by indenture bearing date on the day last mentioned, by virtue of the fourth section of the before mentioned act, did assign and transfer unto Phineas Miller, one moiety, or half part, of the title and interest in said invention, which he, the said Eli Whitney had acquired and held, under, and by virtue of the said Letters Patent, as by the said indenture, executed, and recorded in the office of the Secretary of State, in pursuance of said act, (a copy whereof is exhibit B) will more fully appear. And your orators further shew, that, by articles of copartnership, duly made and executed, by and between Eli Whitney, one of your orators, and Phineas Miller, (who hath lately departed this life) it was, on the twenty-first day of June, in the year last aforesaid, agreed that all concerns which in any way respected the employment or disposal, of the invention and improvement in ginning cotton above set forth, should be conducted under the firm of Miller & Whitney, and that by virtue of the said deed of assignment and articles of copartnership and of the aforesaid statute the said Phineas Miller became interested with a joint interest in the invention and in the exclusive right thereto attached by the said Letters Patent, and that by virtue thereof, the said Phineas Miller, in his life time, was, and your orators, executors of the last will, and testament, of the said Phineas, since his death, now are placed on the same footing with the said Eli Whitney, the original inventor, both as to right and responsibility. And your orators further shew to your honors, that by the act of the United States, above stated, and also by an act passed the seventeenth day of April, in the year eighteen hundred, entitled an act to extend the privilege of obtaining patents for useful discoveries and inventions to certain persons therein mentioned, and to enlarge and define the penalties for violating the rights of patentees, it is made and declared unlawful where a patent shall be or shall have been granted, pursuant to either of the said acts, for any person without the consent of the patentee, his or her executors, administrators or assigns first obtained in writing to make, devise, use or sell, the thing whereof the exclusive right is secured to said patentee by such patent. And your orators further shew, that, by virtue of the aforesaid statutes, and by the sanction and authority of the aforesaid Letters Patent, Eli Whitney, one of your orators, and the said Phineas Miller, in his life time, were, and your orators, that is to say, the said Eli Whitney survivor, as aforesaid, and the said Catharine Miller and Lemuel Kollock, executors of the said Phineas Miller, now are and continue to be invested with and entitled unto, and ought of right to have hold and peaceably enjoy the exclusive right and privilege of making, devising, using and selling to others to be used, gins constructed

on the plan and according to the principles of the said invention for the term of years limited by the said patent, according to the true intent and meaning of the acts of Congress and Letters Patent, as above stated. And your orators charge that no machine of a similar construction to the one for which the said Eli Whitney hath obtained a patent was ever invented, or used in the United States, Georgia, or elsewhere for ginning cotton, until invented by the said Eli Whitney; on the contrary, the only mode, method and device, used in Georgia, or elsewhere for extracting green seed as well as black seed cotton from the seed, was by roller gins, which are entire dissimilar in their principles from the present machine of your orator. And your orators do further shew to your honors, and expressly charge that Arthur Fort and John Powell, who are citizens of the State of Georgia, not regarding the right thus constitutionally and legally vested in the said Eli Whitney and Phineas Miller, their representatives and assigns have procured, and since the seventeenth day of April, in the year eighteen hundred, have used and still continue to use a machine for ginning or cleaning cotton, upon the principle of the said improvement and invention, that is to say, a machine-machine for extracting cotton from the seed by means of metallic teeth or points, attached to, and revolving on a cylender and passing through grooves or openings of a breastwork, too narrow to admit the seed, through which grooves the cotton is carried by the teeth, and after passing through is brushed off from the teeth by a cleaner or brush, without the license, assent, or permission of the said Eli Whitney, or of the said Phineas Miller, in his life time, or of the executors of the said Phineas Miller, since his death. And your orators further shew that your orator, Eli Whitney, and the said Phineas Miller, in his life time, have often applied to the said Arthur Fort and John Powell in a friendly manner, soliciting them to desist from the use of the said machine, and the infraction of the said exclusive right, not having obtained a license, or permission from your orator and the said Phineas to use the same. And your orator and the said Phineas well hoped that the said Arthur Fort and John Powell would have ceased to use the said machine and have made compensation to the said patentees for the violation of their patent right, as in justice and equity they ought to have done.

But now so it is, may it please your honors, that the said Arthur Fort and John Powell, combining and confederating with divers other persons, yet unknown to your orators, whose names when discovered your orators pray may be inserted in this bill, with apt words to charge them, designing and intending to oppose the constitution of the United States, as well as the government and laws established and enacted under its sanction, and for this purpose designing by their popular but evil example to induce and promote a general violation of their exclusive right among the citizens of the State of Georgia and thereby deprive the patentees of its advantages, have by some fraudulent, surreptitious means, unknown to your orators, obtained, and do continually without any license or permission from the patentees, use the invention for separating cotton from the seed above set forth, whereof the exclusive right is vested in your orators, as aforesaid. And that the said Arthur Fort and John Powell do absolutely refuse to discontinue the use thereof, at some times pretending that the machine above described is not a useful invention, that, for this reason the patent was fraudulently obtained, and ought to be disregarded in

The defendant, Arthur Fort, saving and reserving to himself now and at all times hereafter all and all manner of benefit of and advantage of exceptions to the manifold uncertainties and imperfections in the complainant's said bill contained, for answer thereunto, or unto so much thereof as materially concerns this defendant to make answer unto, he answereth and saith, That he believeth it to be true that the said Eli Whitney did obtain Letters Patent for the right of making, using, constructing and vending to others to be used a certain machine purporting to be a new and useful improvement in the art of ginning cotton, and that he did transfer one moiety of his right thereunto unto the said Phineas Miller, as stated in the bill of complaint of the said complainants; and also that an act was passed on the 17th uay of April, 1800, to the intent and purport expressed in the said bill of complaint, but this defendant denies it to be true that the machine pretended to be invented by the said Eli Whitney was a useful one because as he hath been informed the cotton ginned or cleaned thereby was materially injured in its staple and texture. This defendant admits that it doth not come within his knowledge that any machine on similar principles was used in Georgia or elsewhere for the ginning of cotton, but he hath been informed and doth verily believe that a machine constructed on similar principles, though somewhat different in its formation had been known and in use in Europe previous to the time of the said Eli Whitney's obtaining his patent, although it might have been applied to a different purpose than that of ginning cotton.

This defendant also admits that he did not know of any other mode of ginning cotton-cotton used in Georgia previous to the time of obtaining the said patent, other than that of rollers. This defendant admits that he hath since the 17th of April, 1800, and a considerable time previous thereto, used a machine for the purpose of ginning cotton consisting of circular metallic plates fastened on a square iron axis, with teeth, cut in the periphery of the plates, and a brush to detach the cotton from the teeth, but he denies that the same is in form similar to that of the Patentee, according to the best of his information, having never seen one of the machines pretended to be invented by Eli Whitney, but whether there is any or what similarity in principle, he cannot say—because having never seen the machine of the Patentee and not being sufficiently skilled in mechanics he cannot be positive. The defendant denies that he hath been requested to desist to use his machine otherwise than by having been sued and harassed and perplexed by the complainants in an action on the common law side of this honorable Court, and by the present bill of complaint on the equity side thereof. This defendant denies that his example has induced a general violation of the rights of the patentees; on the contrary he is inclined to believe that if any infringement has been made on the rights of the patentees that it has been occasioned by the avarice of themselves and agents or some of them. This defendant hath already answered and said that he does not believe the machine for which the patent was obtained is a useful one, and that he doth believe that a machine constructed on similar principles was known in Europe previous to the time of obtaining the said patent. And this defendant also saith. That teeth cut in circular metallic plates is in his opinion, a very considerable improvement. This defendant denies that he hath used his machine in a secret or clandestine manner, but that on the contrary he has never refused any per-

sons the liberty of inspecting or examining his machines, and that his ginhouse at all times at which his machine was at work hath been open for the admission of such persons as had business therein or chose to enter thereinto. That the complainants might have well had their action if to any such they were entitled (which this defendant doth not admit) against him at common law, and that in truth the said Eli Whitney, and the said Phineas Miller in his life time instituted a suit on the common law side of this honorable court for an infringement of their patent, but which they failed to prosecute. That he hath used a machine for cleaning cotton constructed as he hath already described for seven years or upwards, but he cannot say for the reasons already mentioned, and also on account of not seeing the Letters Patent, whether the said machine used by him is constructed on the same principles as that of the Patentees, and this defendant continues to use the same. This defendant is unable to say what quantity of cotton he hath ginned with his machine, as he did not keep any account thereof. That his machine consists of forty-six circles of teeth, and is impelled by water. And this defendant denies all and all manner of confederacy and combination wherewith he stands charged in and by the said bill of complaint, without that, that there is any other matter or thing material or necessary for this defendant to make answer unto, and not herein and hereby well and sufficiently answered unto confessed or avoided, traversed or denied, is true. All of which matters and things this defendant is ready to aver and prove as this honorable court shall direct and award, and humbly prays to be hence dismissed, with his reasonable costs in this behalf most wrongfully sustained.

J. HAMILL.
Sol. for Deft.

Sixth Circuit Court, District of Georgia.

Arthur Fort being duly sworn maketh oath and saith, that what is contained in the foregoing answer as far as concerns his own act and deed is true of his own knowledge, and that what related to the act and deed of any other person or persons he believes to be true.

ARTHUR FORT.

Subscribed by the above named Arthur Fort in my presence and sworn to before me this 17th day of December, 1805. R. M. STITES, Clerk.

ENDORSEMENT.

Sixth Circuit Court. E. Whitney and Executors of Phineas Miller vs. A. Fort and J. Powell. Answer of A. Fort, Filed 19th December, 1805. Stites, Clerk. Hamill, Solicitor.

POWEL'S ANSWER.

IN THE CIRCUIT COURT OF THE UNITED STATES, DISTRICT OF GEORGIA.

Eli Whitney, surviving copartner and executors of Phineas Miller, complainants, vs. John Powell, defendant. In Equity.

The answer of John Powell, defendant in the above case. This defendant saving and reserving to himself all and all manner of exceptions to the manifold errors and imperfections in the bill of complaint of said complainants, for answer thereunto or unto so much thereof, as he is advised is material for him to make answer unto, he answereth and saith, That he admits that a patent was obtained by Eli Whitney, one of the complainants, for the invention of a cotton gin, or a machine for cleansing and separating cotton from its seeds, at the time and in the manner set forth in the bill of said complainants, and he admits it to be true that he hath heard and believes the said Eli Whitney did after-

wards transfer and assign to Phineas Miller, now deceased, a moiety of the said invention, and the rights attached thereunto, under the patent aforesaid, and he admits it also to be true that, said Phineas Miller did by his last will and testament nominate and appoint Catharine Miller and Lemuel Kollock, executors thereof. This, defendant also admits it to be true that he does hold, use and occupy a machine or gin for cleaning cotton, commonly called a saw gin; that the said gin has a wooden frame, and a breast, made of pieces or straps of iron, placed at such a distance from each other, as to admit the teeth of circular metallic rows to pass through the grooves of said breast, that there is a revolving cylender on which at regular distances from each other are placed circular metallic iron plates, containing teeth, all cut and inclined one way; these teeth pass when revolving between the straps or pieces of iron affixed to, or forming the breast, and separate the cotton placed within the hopper from its seeds; that it contains a brush made of the bristles of hogs, affixed to a cylender revolving in a contrary direction to the one containing the circular metallic plates or saws, and detaches the clean cotton from the saws or teeth. The machine is put in motion by a whirl fastened to the axis of the cylinder first mentioned, round which is a band and propelled by horse. This defendant denies all unlawful combination with which he stands charged without that, there is any other matter or thing material or necessary for this defendant to make answer unto and not herein and hereby well and sufficiently answered unto, confessed or avoided, traversed or denied is true. S. JONES.

Solicitor for Defendant.

Jefferson County, ss.

John Powell of Louisville, practitioner of physic, being duly sworn maketh oath and saith that the facts set forth in his foregoing answer is true, so far as the same concerns his own act and deed, and what rests on the knowledge of others, he believes to be true. JNO. POWELL.

Sworn to and subscribed before me 1st May, 1805.

M. SHELMAN, J. J. Ct.

ENDORSEMENT.

Eli Whitney and Executors, Miller vs. A. Fort and J. Powell. Answer of John Powell. Filed 6th May, 1805. Stites, Clerk.

Arthur Fort vs. Miller and Whitney, Case 9.

And the said Arthur Fort by Robert Watkins, his attorney, comes and defends the wrong and injury, when &c., and saith that he is not guilty of he premises above charged on him against the form of the statute aforesaid as the said Phineas and Eli have above against him complained and of this he puts himself upon the country, &c.

WATKINS,
Defendants' Attorney.
R. M. STITES, Clerk.

9. A. Fort ads. Miller, &c. Plea filed.

Circuit Court, Georgia.

DECREE FOR INJUNCTION.

Eli Whitney, et al, vs. Arthur Fort. Bill for injunction.

This cause came on to be heard this 19th day of December, eighteen hundred and six, before the Honorable Wm. Johnson and the Honorable Wm. Stephens, on bill, answer, replication, testimony and exhibits, in behalf of the complainants.

Whereupon it is ordered, adjudged and decreed that the injunction prayed for by the complainants in their bill be granted them and that the same be

made perpetual, and that the defendant pay the costs of this bill.

Dated at Louisville, this 19th day of December, A. D., 1806, and in the 31st year of American Independence.

WILLIAM JOHNSON, JR.
WM. STEPHENS.

ENDORSEMENT.

Georgia 6th Circuit Court. Whitney, et al, vs. Arthur Fort. Decree for Perpetual Injunction 19th December, 1806. Ent. page 13 and 14. STITES, Clerk.

NOTE. The words in the various documents which are repeated at intervals, thus-thus, are supposed to be the words which were formerly repeated at the bottom of the page. The clerk in making the certified copy must have copied these words verbatim.

D. A. T.

Document VI.

CERTIFIED COPY OF HODGEN HOLMES' PATENT FOR SAW GIN, 1796.

This paper is now on file in the United States Court House, Savannah, Ga.

Exemplification of the Patent of Hodgen Holmes.

The United States of America.

To all to whom these Letters Patent shall come:

Whereas, Hodgen Holmes, a citizen of the State of Georgia, in the United States, hath alleged that he has invented a new and useful improvement, to-wit, new machinery called the cotton gin, which improvement has not been known, or used before his application, has made oath that he does verily believe that he is the true inventor or discoverer of the said improvement, has paid into the Treasury of the United States, the sum of thirty dollars, delivered a receipt for the same, and presented a petition to the Secretary of State, signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted for that purpose: These are therefore to grant according to law, to the said Hodgen Holmes, his heirs, administrators, or assigns, for the term of fourteen years, from the nineteenth day of the month of April last past, the full and exclusive right and liberty of making, constructing, using and vending to others to be used the said improvement, a description whereof is given in the words

of the said Hodgen Holmes himself in the schedule hereto annexed and is made a part of these presents.

In testimony whereof, I have caused these letters to be made patent and the seal of the United States to be hereunto affixed. Given under my hand at the city of Philadelphia, this twelfth day of May in the year of our Lord, one thousand, seven hundred and ninety-six, and of the Independence of the United States of America the twentieth.

By the President,
GEORGE WASHINGTON.
TIMOTHY PICKERING,
(L. S.) Secretary of State.

City of Philadelphia, to-wit:

I do hereby certify that the foregoing Letters Patent were delivered to me, on the twelfth day of May, in the year of our Lord, one thousand, seven hundred and ninety-six, to be examined, that I have examined the same, and find them comformable to law, and I do hereby return the same to the Secretary of State within fifteen days from the date aforesaid, to-wit:, on this tweltfh day of May, in the year aforesaid. CHARLES LEE,
Attorney General.

The schedule referred to in these Letters Patent and making part of the same containing a description in the words of the said Hodgen Holmes himself of an improvement, to-wit: new machinery called the cotton gin.

EXPLANATION OF THE WHOLE MACHINERY.

This machinery for cleaning cotton from the seed, can be used in the following manner, viz: The whole machine (standing on the floor) is made of wood, six feet, six inches wide, five feet long and five feet high, by putting this machine in motion for use of the before mentioned purpose, is to be done by the following direction:

The cylender from eight to fourteen inches in diameter, and six feet long with one row of teeth, to one inch, which runs on two iron gudgeons, the feeder from eight to twelve inches diameter, with two rows of wires of one inch, and six feet long and runs on two iron gudgeons, the brush from seven to twelve inches in diameter, and six feet long, with two iron gudgeons to each cylender, from three-quarters of an inch to one inch thick.

HODGEN HOLMES.

Teste, W. Urquhart. Seaborn Jones.

Department of State, to-wit:

I hereby certify that the foregoing Letters Patent from the United States to Hodgen Holmes are a true copy of the original on record in this Department.

Given under my hand and seal of office the twenty-first day of October, 1797.

(Seal.) TIMOTHY PICKERING.

NOTE.—This document gives Holmes a residence in Georgia. Augusta, Ga., was the actual place referred to. It appears from other accounts of Holmes that he sometimes lived in Hamburg, S. C., which was a town in Edgefield county, on the opposite side of the Savannah river from Augusta. This explains why Holmes is frequently referred to as being from South Carolina.

His legal citizenship was probably sometimes in Georgia and sometimes in South Carolina. D. A. T.

Document VII.

LETTER FROM PHINEAS MILLER, OF MULBERRY GROVE, GA., TO HIS PARTNER, ELI WHITNEY, NEW HAVEN, CONN., FEBRUARY 15, 1797.

This is copied from "Correspondence of Eli Whitney, relative to the Invention of the Cotton Gin."

By M. B. Hammond in The American Historical Review, October, 1897.

Mulberry Grove, Feb. 15th, 1797.

DEAR WHITNEY: The mystery of your silence is unravelled and I am much rejoiced—during my absence to the upper country your letters of 17 and 27 Nov., the 16th and 20th of Dec. and 6th Jan. came to hand. Not one of these reached here until the latter part of January, the letters by Bontacee had carelessly been retained by the person who brought them.

Your advice respecting the mistake most probably committed by the Rhode Island Factory is agreeable. My anxieties on this subject are kept awake by the large sum we have at stake. You are almost surprised that my confidence should be shaken; the people here are surprised that it should not be entirely destroyed.

I think your advice good respecting keeping a supply of cotton at New Haven and New York. I have only been prevented from pinching necessities doing this heretofore, and shall proceed as much as my funds will possibly admit this winter. I have indeed endeavored to extend my credit to the purchase of 40 or 50 m. weight of cotton at the low price at which it is to be had at present—viz: $3.50, and for cash $3 per hundred. I have also set on foot in common with Mr. Rupel a traffic over the mountains to the distance of three hundred miles by land, which I think will enable us to vend a few thousand weight of cotton very profitably.

Fortunate have we been in one instance among so small a number of misfortunes in saving our cotton and samples of cotton at New York. The repeated disappointments which have yet prevented your departure for England have become so frequent that they almost cease to create surprise, and yet the evil arising from the detention is by no means diminished. I really think that it will not be best that Nightingale should engage with us until some change in our affairs can be brought about. We require at present his assistance and I should wish to make him the most liberal recompense without subjecting him to our misfortunes, in addition to his own.

It will be best to take the deposition of Goodrich and Stebbins on the subject of ratchet wheels which may hereafter be rendered useful. I fear it cannot be had in time for our Court which will sit the last of April. The name of the Patentee for the surreptitious patent I think is Robert Holmes. The names of our defendants, Kennedy and Parker and Edward Lyons. I expected you would have procured and sent on the copy of the patent which was to be set aside. I shall now write for it myself. The order which was given to Adams for the saw mill crank was sufficiently correct. I find by his letter that he understood it exactly as was intended—but the difficulty arose from my omitting to explain the mode of our applying these cranks which did not appear to me necessary. It is now too late to make them—others are procured.

With best wishes for your early departure and with the regards of our family, I am truly your friend,

PHINS. MILLER.

Document VIII.

LETTER FROM ELI WHITNEY, NEW HAVEN, CONN., TO JOSIAH STEBBINS, NEW MILFORD, DISTRICT OF MAINE, OCT., 15, 1803.

This is copied from "Hammond's Correspondence, above cited.

New Haven, 15th Oct., 1803.

DEAR STEBBINS: The fates have decreed that I shall be perpetually on the wing and wild goose like, spend my summers in the North and at the approach of winter shape my course for the regions of the South. But I am an unfortunate goose. Instead of sublimely touring thro' the aerial regions with a select corps of faithful companions, I must solely wade thro' the mud and dirt a solitary traveller.

While on my tour the last winter I wrote you several letters to several of which I have recd. no answer. I wrote you a letter from the city of Washington almost a year since, in which I gave you some account of Thos. Paine. I feel a little anxious lest this letter may have miscarried. I wrote you also last spring from Savannah (if I recollect rightly) requesting some information relative to my invention of the cotton machine. I should be gratified to know whether you recd. these letters or not.

I shall start from here in ten days for South Carolina in order to be there at the meeting of the legislature of that State and expect to return in January or February. A multiplicity of avocations has prevented my writing you for some time past and it has ben so long delayed that I fear I shall not be able to get an answer from you before I commence my journey.

I have still a host of the most unprincipled scoundrels to combat in the Southern States. I have not now leisure to go into detail but I want to enquire of you if you cannot give your deposition to the following import, (viz:)

I, Jos. Stebbins, &c., &c., do testify and declare that I have been intimately acquainted with Eli Whitney, originally of Massachusetts, but now of New Haven in the State of Connecticut, for more than fourteen years. That the said Whitney communicated to me his discovery and invention of a machine for cleaning cotter from its seed by means of teeth passing between bars or ribs of a part which he called a breastwork, more than six months before he obtained a patent for said invention.2 That I saw sd. Whitney almost every day thro' the summer and autumn of the year 1793, at which time I was a resident graduate in Yale College. That we had many and frequent conversations on the subject of mechanics and natural philosophy in general and particularly with reference to his said invention. That I transcribed his specifications or description of said machine several times and that he conferred with me relative to the various parts of said description. And I well remember that said Whitney repeatedly told me that he orignally contemplated making a whole row of teeth from one plate or piece of metal such as tin plate or sheet iron and that he afterwards had recourse to wires to make the teeth from necessity, not having it in his power at that time to procure either tin or sheet iron in Georgia. That in the first draft of his specification he had mentioned sheet iron as a material out of which the teeth might be made but we concluded it was wholly unnecessary as it did in no way affect the principle of the machine being only one of a great variety of methods in which the tee h might be made and it was struck out. I also recollect that the said Whitney previous to writing a description of his invention had contemplated a variety of

methods of making each of the several parts of the machine but it was thought to be wholly immaterial that they should be mentioned in the description, etc., etc.

I hope you will be able to call to mind the circumstances mentioned above, not that they would be of any importance with an enlightened upright judge. The circumstance of making the teeth of sheet iron is really of no account as it regards the principle and my right; but as that is the method in which the trespassers make themachines, theylay great stress upon it, and if I can but prove the truth about it, it will stop their mouth on this subject. I have a se' of the most depraved villains to combat and I might almost as well go to hell in search of happiness as apply to a Georgia Court for justice.

I fear that I have delayed writing to you so long that I cannot get an answer from you before I leave this, which will be as early as the 25th of this month. But I would thank you to lose no time in writing to me and direct to me at Columbia South Carolina—whatever your recollection will enable you to testify to, relative to the early history of my invention. I wish you to forward to me a deposition signed and sworn to. I am sensible such a deposition will not be recd. in a court of law, there being no commission taken out to take the testimony but it will be very useful to me in some important arrangements which I wish to make. I hope it will be convenient for you to write me soon after you receive this as any delay will dprive me of any benefit which I may derive from your deposition.

I shall not make any considerable stop before I reach Columbia in So. Carolina, which place I do not now expect to leave before the 20th of December. Write me as much and often as you can. I shall have more leasure to write you while traveling than I have had the summer past and you may expect to hear from me occasionally.

My armoury here has got to be a regular establishmbent and progresses tolerably well, and I flatter myself I shall make something handsome by the undertaking. My works have considerably excited the public curiosity and are visited by most people who travel thro' this country, this however is not so flattering to my vanity that I do not wish to be less thronged with spectators. It would really give much sincere pleasure and satisfaction to see you here and shew what I have been doing for three or four years past. Can you not visit us next summer?

With best and most affectionate regards to Laura and ardent wishes for your (own) happiness, I am, have been and (shall be)

Your sincere friend,

E. WHITNEY.

Josiah Stebbins, Esq.

Document IX.

ABSTRACT OF LEGISLATIVE RECORDS, ON FILE IN STATE HOUSE COLUMBIA, S. C., RELATING TO THE PURCHASE BY THE STATE OF SOUTH CAROLINA, OF THE PATENT RIGHTS TO THE WHITNEY GIN.

In the Senate, Dec. 1, 1801, Major John Turner presented a petition from "Sundry Inhabitants of Richland County," praying that the State purchase for the free use of i s citizens, the patent right to the machine known as the "saw gin.'

In the Senate Dec. 7, 1801, Dr. Blythe of All Saints, presented a petition to the same effec from "Sundry Inhabitants of Kershaw County." The petitions were referred to a joint committee from House and Senate, composed on the part of the Senate:

Major John Turner of Richland County, Col. Joseph Calhoun of Abbeville County, Capt. Arthur Simpkins of Edgefield County, and on the part of the House:

Mr. Taylor, Mr. Peter Porcher, Jr., Dr. Hanscome, General Robt. Anderson, Mr. John Richardson.

The Senate committee reported Dec. 12, 1801:

That they have met a committee from the House of Representatives for the purpose appointed and "they have taken into their joint consideration the matters contained in said memorials, and have had full conference with Mr. Eli Whitney, one of the co-partners of Miller & Whitney, who claim the said patent for the exclusive use of the saw gin for cleaning the staple of cotton from the seed within the United States. That the said Eli Whitney for himself and the concern of Miller & Whitney has proposed as the lowest sum they will be willing to take for the patent right within the limit of the State the sum of $50,000. $20,000 to be paid as soon as the said Miller & Whitney shall make a legal transfer of the same to the State or its agent. $15,000 on Sept. 1st and $15,000 on the 18th day of Sept., which will be in the year 1803."

"That taking into consideration the immense advantages which have resulted, and which will result to this State from this most ingenious and useful discovery, as well as the sacrifices which the inventor has made in pursuing and perfecting this great undertaking, as well also as the certainty that if the patentees pursue their right against individuals, a much greater sum would be likely to accrue to them, perhaps four times the amount at present, without taking into view the certain increase which will be made to the number of machines now in use—adding also to these considerations the great propriety of preventing the immense expense of litigation to our citizens on this subject—and that it is becoming and dignified in the State to take by the hand, encourage and foster by its liberality the useful arts.

"They therefore resolved, that leave be given to bring in a bill for the purpose of purchasing from Messrs. Miller & Whitney, their patent right to the making, using and vending the saw machine within the limits of this State and for compensating them for the same.

"They further recommend that a tax should be laid on the same machines now in the State to the amount of......for every saw or round or row of teeth in the said machines for the purpose of defraying the second installment of the aforesaid purchase to be made; and that it be considered that the tax upon these machines be pledged for the purpose of reimbursing the State for the purchase to be made aforesaid."

ORDERED

that the report be considered on Monday next.

On Dec. 14, 1801, the Senate agreed to the committee report and returned same to committee to bring in a bill in conformity thereto. This bill was brought in and passed Dec. 16, 1801, and sent to the House.

The bill provided that Miller & Whitney should make a legal transfer of the right and title to his patent for the State of South Carolina, and that they should refund to citizens of the State all sums which they had collected therefrom for licenses, and that they should deliver "within a reasonable time" at the State House, two improved models of the gin.

On making the legal transfer, Mr. Paul Hamilton, Comptroller General of the State, made his warrant on the treasury for the cash payment, $20,000.

General Charles Cotesworth Pinkney, of Charleston, was a member of this

Senate. He was one of Whitney's early friends in the South. Another member of this Senate was Mr. Henry Dana Ward, from Orangeburg County. He had been a class-mate of Whitney's at Yale College.

In the Senate Nov. 27, 1802, Capt. Arthur Simpkins of Edgefield County, presented a petition from William Foster, Taylor, praying that the State refund him the money, $160, which he had paid Miller & Whitney as a license to operate a saw gin. This petition was referred to the same committee that reported on the purchase at the preceding session, with instructions to confer with the Comptroller. They report Dec. 15, 1802, that the Comptroller had not made the second payment on the gin patent, and that he held the money subject to the action of the legislature. The petition was granted, and $180 refunded Mr. Taylor.

The regular House committee appointed to examine the Comptroller's annual report, say in their report Dec. 13, 1802, "on the subject of the saw gin that Messrs. Miller & Whitney have not complied with their contract relating thereto, they highly approve the conduct of the Comptroller in suspending the payment of the second warrant and recommend that he be directed to take measures to compel Messrs. Miller & Whitney to refund the money received by them on account of the saw gin."

On the same date the Senate committee report:

"Resolved, that the legislature approve of the conduct of the Comptroller, that he be also directed to institute such suit against the said Miller & Whitney, as may be necessary to try their right to the invention of the machine." The members of this committee were Capt. John Ward of Colleton County, Major Chas. Goodwin, of Winston, and Capt. Sam Warren of Santee.

When the Comptroller's annual report came to the House again, Dec. 1, 1803, it mentioned the fact that the money was still withheld from Miller & Whitney, and that suits had been instituted against them. This part of the report was referred to the original saw gin committee. They did not report during that session.

At the next session, Dec. 6. 1804, Eli Whitney presented a petition to both House and Senate: "Praying that the State would receive two models of the saw gin and comply with their contract in the purchase of the petitioners' patent right to the same." This was referred to the same saw gin committee.

On Dec. 15, 1804, the Senate received the report of the joint committee as follows:

"On the most mature deliberation they are of opinion that Miller & Whitney, from whom the State of South Carolina purchased the patent right for using the saw gin within this State have used reasonable diligence to refund the money and notes received by them from divers citizens and as from several unforeseen occurrences the said Miller & Whitney have heretofore been prevented from refunding the same. They therefore, recommend that the money and notes aforesaid, be deposited with the Comptroller General, to be paid over on demand to the several persons from whom the same have been received upon their delivery of the license for which the said notes of hand were given and said monies paid to the Comptroller General, that he be directed to hold the said licenses subject to the order of the said Whitney; that the excellent and highly improved models now offered by the said Whitney be received in full satisfaction of the stipulations of the contract between the State and Miller & Whitney, relative to the same; and that the suit commenced

y the State against the said Miller & Whitney be discontinued. The joint committee taking every circumstance alleged in the memorial into their serious consideration, further recommend that (as the good faith of this State is pledged for the payment of the purchase of said patent right) the contract be now fulfilled, as in their opinion it ought to be, according to the most strict justice and equity. And although from the documents exhibited by said Whitney to the committee, they are of the opinion that the said Whitney is the true original inventor of the saw gin; yet, in order to guard the citizens from any injury thereafter, the committee recommend that before the remaining balance is paid, the said Whitney be required to give bond and security to the Comptroller General to indemnify each and every citizen of South Carolina against the legal claims of all persons whatsoever, other than the said Miller & Whitney to any patent or exclusive right to the invention or improvement of the machine for separating cotton from its seeds, commonly called the saw gin, in the form and upon the principle which it is now and has heretofore been used in this State.

On the vote to adopt the report there was a tie vote, 15 to 15. The President of the Senate voted with the regular members, and so he could not break the tie. The report was therefore not adopted.

On Dec. 16, the House of Representatives voted to discontinue the suits against Miller & Whitney, and on 19th, it voted to adopt the committee's report. This was reported to the Senate, and they took another vote resulting in favor of the measure by 14 to 12.

Mr. Whitney signed an indemnity bond on Dec. 27, 1804, to Thomas Lee, then Comptroller General. John Taylor, J. M. Howell and Samuel Green, of Richland County, signed the bond with him. The money was then paid Mr. Whitney in full of the original contract.

Document X.

EXTRACT FROM MESSAGE RELATING TO THE GIN MONOPOLY BY GOVERNOR JAMES JACKSON TO LEGISLATURE OF GEORGIA, NOV. 3, 1800.

* * *

And here I request your attention to the patent gin monopoly under the law of the United States, entitled, "An act to extend the privilege of obtaining patents for useful discoveries and inventions to certain persons therein mentioned and to enlarge and define the penalties for violating the rights of patents."

The operation of this law is the prevention and cramping of genius as it respects cotton machines, a manifest injury to the community and in many respects a cruel extortion on the gin holders. The two important States of Georgia and South Carolina where this article appears to be becoming the principal staple are made tributary to two persons who have obtained the patents and who demand, as I am informed $200.00 for the mere liberty of using a ginning machine, in the erection of which the patentees do not expend one farthing and which sum, as they now think their right secured, it is in their power in future licenses to raise to treble that amount from the information given me by a respectable merchant of this town, (Louisville, Ga.,) whose letter on that subject is marked No. 6. When Miller & Whitney, the patentees, first distributed the machine of their construction, they reserved the right of property of it and also two-thirds of the net proceeds of the gin, the expenses of working to be joint between the patentees and the ginners, finding however a defect in

the law under which their patent was obtained they determined to sell the machines, together with their rights vested in them for $500.00 and for a license to authorise a person to build and work one at his own expense, $400.00, but finding, as I suppose, that the defect of the law was generally understood and that they could get no redress in the courts, they lowered the demand to the present rate of $200.00—that they may raise it to the former rates is certain, and that they will do it unless public interference is had, there can be little doubt. I am informed from other sources that gins have been erected by other persons, who have not taken Miller & Whitney's machine for a model, but which in some small degree resemble it, and in improvements, far surpass it, for it has been asserted that Miller's and Whitney's gin did not on trial answer the intended purpose. the rights of these improvement however, it appears by the present act, merged in the rights of the patentees, who it is supposed on the lowest calculation will make by it in the two States $100,000. Monopolies are odious in all countries, but more particularly so in a government like ours. The great law meteor, Coke, declared them contrary to the common and fundamental law of England, their tendency certainly to raise the price of the article from the exclusive privilege—to render the machine or article worse from the prevention of competition and improvement—and to impoverish poor artificers and planters who are forbidden from making, vending or using it without license from the patentees, or in case of doing so, are made liable to penalties in a court of law.

The Federal Court docket, it is said is filled with these actions. I do not doubt the power of Congress to grant these exclusive privileges for the constitution has vested them with it, but in all cases where they become injurious to the community, they ought to be suppressed, or the parties be paid a moderate compensation for the discoveries from the government granting the patent. The celebrated Dr. Adam Smith observed that monopolies are supported by cruel and oppressive laws, such as is the operation at present of the law on the subject—its weight lays on the poor industrious mechanic and planter. Congress, however, did not intend it so, for when the first law on this head was passed in February, 1793, a few individuals only cultivated cotton, and it was not dreamt of as about to become the great staple of the two Southern States, a staple too, which if properly encouraged must take the decided lead of any other (bread kind excepted) in the United States—the steps proper to be taken to remedy this public grievance you will judge of—but I should suppose that our sister State of South Carolina would cheerfully join Georgia in any proper application to Congress on the subject. I am likewise of opinion that the State of North Carolina and Tennessee must be so far interested as to support such application—if you think with me, I recommend communication with all of them

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Document XI.

WHITNEY'S REPLY TO GOVERNOR JACKSON'S LETTER.

Copied from "The Columbian Museum and Savannah Advertiser," Dec. 2[illegible] 1800.

To Governor Jackson:

I have read with sensations peculiar to the occasion your official attack upon our private property, acquired under the patent law of the United States, but we have long doubted whether it were proper to communicate these sensations to the public.

It has always appeared to us that the private pursuits of individual industry are entitled to the most sacred and inviolable protection of the laws, and that a good cause where private right alone was concerned might suffer trivial injuries without acquiring the claim to be presented before the solemn tribunal of public opinion. But when the title to our property is slandered and political persecution openly commenced against us under pretence of official duty by our chief magistrate, silence on our part might be supposed to sanction the abuse. The urgency of the case must, therefore, be our apology for meeting your excellency on this ground, and in making a defence of our property right, we shall draw a veil over the passions which have brought it into question, and, passing over the degraded condition to which the State has been reduced, shall only notice the measure in which we are immediately implicated, and shall consult the genius of our government rather than the acts of your administration, to enable us to preserve towards you that respect to which your office is entitled.

In the first place, your excellency will permit us to remove the deception which is palmed on the public to our disadvantage in the approbrious term "monopoly." The respectable authors whose names were brought forward to sanction your opinion on this subject speak of the exclusive right to carry on a trade or manufacture as a "monopoly," and not of the protection which government chooses to give to the arts. The principle of the patent law, your excellency will please to observe, consists of a fair compromise between the government and the author of the invention. There can be no doubt but what an invention in the arts must remain the exclusive right of the inventor under the most oppressive laws, while the secret is confined to him, and many instances have occurred of the preservation of the secret for years and even of its final loss to the public to the death of its inventor.

To remedy which evil and to stimulate ingenious men to vie with each other, governments, by enacting patent laws, substantially agree that they will afford to the author of the invention the most ample protection in the use of his discovery for a certain term of years on condition that after that period it shall become public property. And in carrying into effect of all such discoveries, it is well-known that every inventor must incur the whole expense and take on himself the entire risk of the success of his invention, in which if he fails, his loss of time and money does not always constitute his greatest mortification, and if he succeeds, the public advantage must of necessity go hand in hand with his acquirements, since the inventor cannot expect his invention to be employed or paid for unless it exceeds all others in point of utility. In the present case, we believe the utility of our invention well known and candidly admitted by all rational men. At the time it was brought forward, there were millions of pounds of cotton in the seed, which awaited the event of some improvement in the mode of ginning, and wealth, honor and gratitude were promised to the fortunate exertions of genius which would insure the culture of green seed cotton to the up-country.

Under such flattering auspices and the protection of the law, the invention was perfected, and at great expense in money, which has never been repaid, and of time and labor, which is unrewarded, and now your excellency would direct your influence to blast the harvest so hardly earned, and which for many years has waived in distant view and buoyed up our hopes under the existence of adversity and oppres-

sion, which would have better suited the perpetrators of vice than the industrious and successful improvers of so useful an art.

The idle stories which your excellency condescends to repeat with a view of dividing with some other person the credit of the invention are not new to us, but we always considered as harmless while they only served to amuse some ingenious mechanic, but the place they hold in the executive message requires us to observe that we know of no pretentions of this kind which can stand the smallest examination, and we challenge the most distant parts of Europe and Asia to produce a model, or a well attested account of a machine for cleaning cotton upon the principle of ours, which was known previous to our invention. We have not even ascertained that a single improvement has been made upon the machine, of which we have not complete evidence of our previous knowledge and experimental use. But whether the form that we have adopted is the best and deserves the preference to that in common use in the up-country, experience must determine. At present public opinion, we acknowledge, in this respect, to be against us.

We have too good an opinion of the understanding of our readers to believe that they can be amused by our following your excellency through the detail of our private concerns. We might as well claim public attention to our mode of planting cotton or cleaning rice. But we are not yet blessed with the vanity which can be made happy by the belief that our words and actions are worthy of scrutiny, and that plain, upright men have a right or wish to know the exact proportion in which we divide our losses or emoluments with the gentlemen who thought proper to be interested in our concern.

The alternative which your excellency suggests of paying a moderate compensation to the patentees, or suppressing the patent, appears to us to be injudiciously chosen, for in the first of these cases, if the bargain is to be all on one side and the persons who would defraud us of our right are to be the sole judges of the compensation to be made the oppression would be too manifest; and the proposition of suppressing the patent is so bold a thing that we forbear giving it comment.

Of the sum of money which we are likely to make on our invention, we do not pretend to judge, but should be highly gratified if the prediction of your excellency should be justified by the event; should it, however, turn out otherwise and should this public instance of persecution and slander prove greatly to our disadvantage, we persuade ourselves that your excellency has too high an opinion of the equal rights of men to be unwilling to submit to a court of justice the extent of the responsibility that you have taken on yourself. Appealing as we do to the candor and liberality of our fellow citizens for the justice of our cause and for the consistency of our conduct, we repeat our assurances that we have appeared before them with regret, and hope that it may be the last time that so much of your excellency's attention will be devoted to the private concerns of your constituents, and more particularly of those who are so desirous of peaceably pursuing their occupation, as your obendient servants.

Signed,

MILLER & WHITNEY.

Document XII.

LAWS
OF
NORTH CAROLINA.

At a General Assembly, begun and held at Raleigh, on the fifteenth Day of November, in the Year of our Lord one Thousand Eight Hundred and two, and in the Twenty-seventh Year of the Independence of the said State.

JAMES TURNER, ESQUIRE, GOVERNOR.

CHAP. I.

An Act to carry into effect a Contract between the State of North Carolina, and Phineas Miller and Eli Whitney.

WHEREAS Eli Whitney, the inventor and patentee of a machine for cleaning cotton from the feeds, commonly called a Saw-Gin, has propofed and offered, in behalf of himself and Phineas Miller, assignee, of one moiety of the patent-right to faid machine, to fell to the State of North-Carolina, the fole and exclusive right of making, ufing and vending the faid machine within the limits of this State: And whereas the cultivation of cotton is increafing in this State, and from the invention and ufe of faid machine, likely to become a valuable ftaple article of exportation, it is expedient that the State of North Carolina do purchafe from the faid Miller and Whitney, the patent-right to the making, ufing and vending the faid new invention of a machine for cleaning cotton from its feeds, commonly called a Saw-Gin, on the terms and conditions hereinafter mentioned; that is to fay, that there fhall be laid and collected by the State of North-Carolina, on each and every faw-gin which fhall be ufed in this State, between the paffing of this act and the firft day of April next, a tax of two fhillings and fixpence upon every faw, or annular row of teeth, which fuch gin may contain; and a tax of two fhillings and fixpence for each and every faw, or annular row of teeth, which fhall be ufed in faid gins, in each and every year, for the term of five years thereafter. Provided, that the aforesaid Miller and Whitney, before they fhall receive, or be entitled to receive any of the money collected by virtue of this act, fhall produce their patent-right aforesaid, and fatisfy the Treafurer that they are the true proprietors of the fame; which tax, when collected, to be paid to the faid Miller and Whitney, or their order, firft deducting the Sheriff's ufual commiffions of fix per cent. for collection, from year to year for the term aforefaid: The firft payment to be made on the firft day of December, in the year of our Lord one thoufand eight hundred and three, and the laft payment on the firft day of November, in the year of our Lord one thoufand eight hundred and eight: For which purpofe,

Be it enacted by the General Affem-

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Document XIII.

COMPTROLLER's STATEMENTS.

The following Statements, marked A. B. and C. and the List of Delinquents, are printed at the end of the Laws, agreeable to a resolution of the General Assembly, passed on the 20th of December 1803.

[A]

A STATEMENT

Of the net amount of each branch of the Revenue of the State of North Carolina for the year 1802, except hat part which is receivable by the Clerks of the several Superior and County Courts.

COUNTIES.	Amount of the Land Tax £	s	d	Amount of the Poll Tax £	s	d	Amount of the Stud Horse Tax. £	s	d	Amount of the Town Property Tax. £	s	d	Amount of the Tavern License Tax. £	s	d	Amount of the Cotton Gin Tax. £	s	d	Total Amount due from Sheriffs. £	s	d	Amount paid by Sheriffs. £	s	d
Anson	108	17	2	131	8	3	9	3	4	12	7	10	18	10	9	43	0	2	313	7	6	313	7	6
Ashe	60	1	5	30	15	3	2	2	4				4	10	3				96	9	3	96	9	3
Beaufort	94	16	7	126	4	11	1	17	8	28	8	11	18	16			14	2	270	18	3	270	18	3
Bladen	148	1	8	179	14	7	7	15	2	5	0	1	14	5	10	2	18	9	357	16	1	357	14	1
Bertie	90	12	2	395	5	6	7	3	5	7	7	1	27	1	6	4	14		472	3	8	472	3	8
Brunswick	131	5	7	98	16	3	3	5	10	7	11	1	5	12	10				241	11	7	341	11	7
Burke	225	18	1	156	13	1	8	1	9	5	17	10	9	15	7	6	2	3	422	7	7	422	7	7
Buncombe	219	12	6	97	4		6	13	6	1	15	7	11	5	8				336	11	3	336	11	3
Craven	157	1	2	204	13	10	7	1		108	16	6	47	15	1	11	8		621	15	7	621	15	7
Carteret	46	8	9	78	13	7	1	12	11	5	1	2	15	15	11				147	12	4	147	12	4
Chatham	136	9	10	256	14	4	38	16	6	6	5	1	38	7	1	36	17	11	513	10	9	513	10	9
Caswell	76	12	6	219	19	3	15	0	10				28	4		22	4	3	362	0	10	362	0	10
Chowan	20	1		159	8	6	3	1	2	17	19	1	30	1	8	4	14		244	5	5	244	5	5
Camden	22	2	2	107	7		10	6	10				16	18	5				166	15	5	116	15	5
Currituck	43	12	9	141	17		5	12	10				39	9	8				230	12	3	230	12	3
Cumberland	208	5	8	235	13	2	14	2		77	2	5	56	8		57	11	6	643	2	9	643	2	9
Cabarrus	58	19	5	92	17	6	14	7	1	2	16	6	13	18	3	83	8	6	260	7	3	260	7	3
Duplin	122	5		158	18	10	8	9	3				13	10	9	7	15	2	304	19		304	19	
Edgecombe	116	17	4	207	6	6	25	2	11	15	13	10	40	12	8	15	5	6	519	18	9	519	18	9
Franklin	88	19		298	7	9	31	11	9	3	1	5	16	18	5	21	0	8	393	19		393	19	
Granville	134	15	10	308	7	10	38	13	9	3	8	5	52	5	4	13	7	11	635	18	1	635	18	1

Gates	40	1	10	169	15	4	8	18	6				15	8	4				243	4		343	4	
Greene	43	9	6	101	16	1	11	5	8				4	10	3				161	1	6	161	1	8
Guilford	113	18	6	197	13	8	13	15		1	2	2	27	1	6	9	17	5	363	8	3	363	8	3
Halifax	138	13	5	489	17	3	71	8	10	8	12	4	48	10	1	4	14		681	15	11	681	15	11
Hertford	51	5	9	179	1	5	7	13	7	8	13	1	27	1	6	4	14		278	9	4	278	9	4
Hyde	89	13	10	106	12								15	15	10				212	1	8	212	1	8
Iredell	111	17	7	173	19	11	22	7	6	8	17	7	29	6	7	60		11	401	10	1	401	10	1
Johnston	141	13	5	158	6		22	1	10	4	19	3	15	8	4	26	4	1	368	12	11	368	12	11
Jones	63	5	6	128	4	11	16	16	3	2	0	1	13	3	3	4	14		220	4		230	4	
Lincoln	161	12	7	188	3	10	13	12	3	5	12	7	29	6	7	68		10	460	8	7	460	8	7
Lenoir	58	5	11	110	7	3	10	11	6	2	11	4	15	8	4	14	9	1	211	13	4	211	13	4
Martin	56	7	3	146	14	9	10	16	3	3	10	6	15	8	4				232	17	1	187	8	
Mecklenburg	168	14	7	217	6	7	28	8	9	3	8	6	20	6	1	253	16		627	0	6	627	0	6
Montgomery	113	3	9	154	18	3	17	19	1	3	2	8	32	6	9	64	3	2	365	13	8	321	10	6
Moore	95	5	10	94	15	1	6	11	8				20	6	1	22	11	3	239	9	11	231	9	11
Nash	94	5	3	175	19	5	20	12	8				15	15	11	2	18	9	309	12		301	12	
New Hanover	98	11	10	207	14	10	2	16	5	104	7	10	43	19	11	5	17	6	457	8	4	457	8	4
Northampton	90	8	1	358	19	9	30	8	8	2	1	5	19	3	7	32	13	4	533	14	10	533	14	10
Orange	161	0	8	338	8		51	11	8	15	5	8	13	18	3	17	12	6	507	16	9	507	16	9
Onslow	74	3	10	132	12	9	4	9	4	2	7		21	8	8	5	17	6	240	19	1	240	19	1
Pasquotank	85	17	4	128	15	8	9	12	9	7	18	1	18	1					200	4	10	200	4	10
Perquimons	89	17	4	136	7	11	16	9		3	8	2	7	10	5				203	7	10	208	7	10
Pitt	95	1	9	200	6	4	23	19	5	5	2	1	27	1	6	2	16	3	354	7	6	354	7	8
Person	96	6	9	164	15	8	12	3	10				21	16	2	16	3		281	3	5	281	3	5
Rutherford	190	14	5	156	0	4	20	6	1	3	0	4	28	4		45		1	454	5	3	454	5	3
Rowan	211	4	10	374	0	7	46	15	10	14	13	1	26	14		75	3	8	748	10		748	10	
Randolph	115	19		144	11	6	28	8	9		18	4	22	11	3	16	13	9	327	2	7	327	3	7
Rockingham	89	3	3	155	19		15	5	6	1	19	5	31	4	2	10	11	6	395	1	10	335	1	10
Richmond	75	3	9	110	18	5	1	8	3	2	12	3	12	0	8	54	3	5	356	5	9	356	5	9
Robeson	184	4	11	125	18	3	7	12	9	4	12	4	33	16	10	14	18	6	361	4	7	360	4	7
Stokes	128	16	6	168	7	1	23	2	9	4	6	1	24	16	4	13	7	11	361	16	9	361	16	9
Surry	137	13	5	157	14	8	16	9	6				18	1					329	18	7	329	18	7
Sampson	130	5	8	151	14	4	10	3	3				20	6	1	21	10	1	333	18	4	333	18	4
Tyrrell	89	3	9	68	14	8	7	5	9				16	18	5				177	1	5	177	1	5
Wayne	94		3	159	6	8	30	8	11				20	6	1	36	3	10	320	5	8	320	5	8
Wake	190	5	1	337	3	7	21	3		28	19	3	24	16	4	28	18	2	601	5	5	604	5	5
Warren	98	13	9	338	19	8	31	19	3	11	15	2	28	11	7	32	15	8	532	18	1	533	18	1
Wilkes	65	4	4	118	10	9	14	3		4	11	9	6	15	5	4	18	9	217	4		217	4	
Washington	53	17	8	74	9		6	3	3				11	5	8				145	14	3	145	14	3
	£6878	5	7	10854	8	0	956	3	11	562	19	3	1308	14	9	1296	8	10	21312	0	4	21142	8	1

December 8, 1808.

Extracted from the Documents in the Comptroller's Office of North Carolina.

J. CRAVEN, Comptroller.

DAIRYING AND BREEDING.

From Bulletin No. 24 Alabama Experiment Station.

This bulletin is not intended to make every land-owner and cotton-raiser an exclusive dairyman, nor is it presumed in its presentation to attempt to cover the wide and important field of dairying. Its object is to mainly throw out a few suggestions for the careful consideration of the farmers of the State, as well as to give some practical thoughts and demonstration of facts from our experience as a breeder of Jersey cattle. It is exceedingly unfortunate that the masses of our farmers are so ill-informed on this matter. But few of them read a dairy or stock paper of any sort, hence have no knowledge of many important facts with reference to stock breeding and its management. It is with the hope of instructing this class of farmers that we propose to send out this bulletin.

Let me beg you not to conclude, because you do not own a fine herd of Jersey or other pure bred cattle, that this is of no interest to you. If you own only one cow it will pay you to inform yourself as how best to manage and feed her, and if together with securing this information you will procure, at reasonable cost, recently improved appliances for butter making, your wife, who generally has the bulk of the work to do in this department, will rise up and call you blessed. So then subscribe at once for some good stock and dairy paper and learn from the practical experience of others how to feed and manage your cows, and the best process of making butter with the least cost and labor.

The great majority of farmers of Alabama own from six to eight milch cows, others own many more, and a few none. It is frequently the case that a man milking five cows does not make a pound of butter for sale. The first trouble is, most cotton producers own too many cattle. Sell off all your non-paying and worthless cows, and re-invest this money in more feed (if you have not already a sufficient quantity on hand), a good comfortable stable for the cow, and a few, at least, of the many important dairy implements. An important step for the farmer who decides to improve his cattle is the purchase of a bull.

Grading up your herd in the right way is of the first importance; and do not cherish for one moment the thought that you own in one of your native cows one that is superior to all others for milk, butter and beef, "a general purpose cow," and propose to raise and use in your herd a bull calf from her. You do not own such a cow, nor ever will.

If you want butter, buy a Jersey or Guernsey; if milk, Holstein or Ayrshire; beef, Shorthorn or Hereford. There are other breeds worthy of note. These are used by way of illustration, as they have been bred for a specific purpose for a long time; and the buyer when he gets a representative animal of either breed, knows what he is getting before he pays his money. Once in awhile there will appear a phenomenal butter cow of the milk and beef breeds, or a phenomenal milker of the butter breeds. Pay no attention to this, it is the breed you are after, backed by indisputable performance

both at the pail and at the churn.

There are plenty of reliable breeders of the different breeds that will sell you a bull at a reasonable figure. Fifty dollars will buy a very good bull, one hundred dollars a much better one. It may be that you cannot afford this outlay, as you have but few cows; in this case your neighbors can join you. Co-operate; use your order, the Alliance. First, decide on the breed; next, buy as near home as you can, thus avoiding acclimating fever. If you cannot find what you want in your own State, then go out of it. Get the best. The bull is half the herd, and under no circumstances use a grade.

Get your natives in good condition and test each cow by the churn. The cow giving the largest flow of milk does not always make the most butter. Quite often the very reverse is true. Continue along to weed out, keeping the best until you breed a model dairy cow.

What is a model dairy cow? One of medium size, small head, full and placid eyes, neck long, thin and clean, broad hips and back of great breadth at the loins, large, roomy stomach, short legs, large udder, medium sized well placed teats, tortuous milk veins. The escutcheons, like the solid color, is thought to be desirable by some, but many good dairy cows have first-class escutcheons and others equally as good have very poor ones.

The cow when well fed should, of course, give a large quantity of good rich milk.

Do not be a "stickler" on color or size, or decide to let a cow remain in your herd because she has a good escutcheon and pretty horns. If she only weighs 600 pounds, is as black as a crow, and has neither escutcheon or horns, but yields the butter, keep her. You want the cow that will produce the most butter at the least cost.

Beware of in-and-in breeding; perhaps you have already paid dearly for it. With perfect animals on both sides and in the hands of a skillful breeder it may do, but as now practiced, it is ruinous, and why should you in-breed so much? There is no necessity for it. Breed to the winner, and it is not out of place to say that this Experiment Station has been practicing in-and-in breeding for a number of years with a small herd of Jersey cattle, the ill effects of which cah be seen by any practical breeder. The old cows are still the best, and one of the last heifers that come in milk young and which is intensely in-bred, had no fore udder at all. The foundation stock is deficient here. The experiment has proven conclusively, both in form and at the churn, that unless you have perfect animals on both sides to start with, and you are skilled, it is best not to undertake it.

If you have no barn, and no means to build one, make a shed, plank up the north and west sides, have separate stalls or fastenings for each cow, either stanchion or halter, and do not allow them to run all over your cow pen, as practiced by most farmers. Take your calves away from the cows at four to six weeks old. Feed your cows well. The most costly thing on a dairy farm is a poor cow. Milk and feed regularly, make them comfortable (this word implies a great deal), and with kind treatment, they are certain to respond.

Feed-tables are sometimes given to show you how much feed to use. Remember that it requires more than a maintenance ration, and that you cannot get good results from raw cotton seed and shucks, for instance.

Many farmers have asked, "how do you raise your calves?" We practice here the following plan: The first milk from the cow's udder acts as a physic, and the calf should be allowed to take it. When the calf is four days old,

separate it from its mother; after 12 hours of fasting, take a couple of quarts of its mother's milk, warm from the cow, dip the fore and middle fingers into the milk and insert into the calf's mouth. If it is very unruly back into corner of the stable and get straddle of the calf's neck. Repeat this until the calf sucks the fingers. Do not lose your patience. It is certain to throw up its head. Lower it until the mouth comes in contact with the milk in the pail, and when it begins to drink the milk, gradually withdraw the fingers from the mouth. The calf will continue to throw up its head many times, but with patience, repeat the process until tne calf continues to drink the milk after the fingers are withdrawn. It will generally do this at the third or fourth trial. Two quarts of milk three or four times a day is all that it will take for the first three weeks. At the end of this time, add a gill of sweet skimmed milk, heated to blood heat (98 degrees) to each feed, twice per day, and 12 hours apart until the quantity is increased to three quarts. Continue this for ten days, then decrease the new milk one gill at feed until no new milk is given; at the same time increase the warm skimmed milk half a pint at a feed until it reaches a gallon. Skim the milk after it sets 12 hours, and always feed it blood warm and while .. is perfectly sweet. The great object in thus changing so gradually from new to skimmed milk, is to avoid the "scours." Bright hay or fodder snould always be accessible after a few weeks old. Corn and oats mixed may be put in the feed trough; the calf will soon learn to eat and chew its cud. Keep the calves in a dry, clean stable with plenty of pure water and salt when a few months old. At seven months, take the milk entirely away, and continue to feed and let them run on in good pastures. Breed at 18 months old. We use linseed meal here with the milk to raise our calves.

At present the cows at this station are fed at 5:30 a. m., and 4:30 p. m. The first thing in the morning is to clean and sweep the stables. The cows are then fed and groomed, udders brushed carefully, and with a clean rag and bucket of tepid water, washed and wiped dry with a clean towel. The milker is now ready for business, and with clean hands and short finger nails, he goes at his job with both hands quickly and quietly. The milk is weighed from each cow and a record is kept. It is then strained through a wire cloth strainer into a ten-gallon can and carted to the dairy. The details of our method have been given in order to show that good butter-making must begin at the barn.

When no experiments are being carried on, we feed an ensilage, and one-third each of corn meal, ground oats and bran, giving what the cows will eat clean.

It may be of interest to many farmers that we give a short, plain and simple way how we make butter. We have the facilities for making good butter, viz: a good dairy hand-power separator, cooling creamer, ripening vat, butter worker, print, etc., besides an automatic fermenting can and automatic ripening vat, and a good well of pure water, though not cold.

After the milk is carried to the dairy it is run through a hand-power separator. The cream is at once cooled down to 55 degrees, placed in a creamer, and kept sweet until enough cream is gathered for churning. It is then poured into a cream vat to ripen, kept at a temperature of 70 degrees, and well stirred during the ripening period. As soon as it is slightly acid, it is ready for churning. Cool down to 62 degrees, scald out the churn well, and pour in the cream. When the granules of butter are the size of wheat grains, the churn is stopped and rinsed

down with a gallon of cold water (56 degrees). A few swings of the churn, and the butter-milk is ready to be drawn off. Wash the butter with about the same quantity of cold water as you have butter-milk; in two washings the water is clear. Tilt the churn to one side and let the butter drain thoroughly. It is then taken up and placed on a butter tray, weighed and salted, one ounce to the pound. Put on the worker, and work only enough to distribute the salt. Print into one-pound prints, wrap with paraffine paper, and forward to the consumer. When making butter in this way, we stir the cream. Never mix sweet and sour cream. Ice is necessary in summer.

What to do with the milk is an important question, and one you must decide for yourself. There is more money lost by the farmers of Alabama between the milk pail and the churn, through ignorance and carelessness than they are aware of. You fail to get money out of your cows by improper feeding and handling, then after you get the milk, a large per cent. is lost by manipulation, by having only few, if any, of the improved dairy implements and no dairy proper. This is to be expected. Stop and reflect whether you can afford to do this any longer; you say that a dairy is costly, and it generally is, but this is not the kind that the cotton raisers need. Buy the right sort of dairy goods, and a cheap structure will answer your purposes. Is not your milk carried now from the "cow-pen" to the house cold, and the cream on top strained into jars and set away to turn. As the weather continues cold, are not the jars transferred from your faulty cellar or shed room to the family room or kitchen, there to remain two, three, and sometimes four days? Your wife turns the jars to the fire often during the day, and the milk will not turn, and all the while it is getting spoiled. She gets disgusted and attempts to churn it, and with a dash churn begins. Generally she knows what to expect. Not having a thermometer, the boiling water is poured in, and something that you call butter is taken out. The fermenting can and cream ripening vat will do away with this, and if you will visit this station, as you should, we will convince you on this point. A little money expended for dairy goods will furnish you the means for making a good article of butter and will be a great relief to your over-worked wife.

The actual cost of feeding will vary in different portions of the State. Each farmer knows what he can grow in the section in which he lives. Barley, rye, corn, millet, sorghum, peas, cotton seed and in many sections of our State, the clovers and grasses grow to perfection. Those farmers who intend to increase the number of dairy cattle to 20 or 25 milch cows should by all means build a silo. Corn pea-vine ensilage is the most nutritous and cheapest feed we have. Try it.

The attention of farmers is called to the following maxims, derived from my own experience and that of other practical dairymen

Feed your cows twice per day, at regular intervals, and have pure water and salt always accessible.

You do not need a dog to drive up dairy cattle.

A dairy cow does not need as much exercise as a trotting horse.

A cow with good escutcheon and nothing else should be butchered.

A yellow skin we like to see, but it is not always a true index to the color of the butter. The butter from a pale-skin cow is often yellow.

Your "scrub" cows are averaging you not more than 100 to 125 pounds of butter per year. You should try to double this yield.

The cow likes a variety of food.

gratify her taste as often as you can.

The winter dairy pays best, therefore breed the most of your cows in December and January, and they will be fresh in September and October following.

Decide on the breed and stick to it.

There are many worthless cows in every breed.

The cow is a machine for the manufacture of milk and butter, and the stomach is the bast laboratory i world for this purpose.

There are many ways to test the ri h-ness of a cow's milk besides the churn; and every dairyman should have a tester. The farmer can use the churn if he prefers to do so.

In ordering your dairy goods, the first thing to put on your list is a thermometer. It is more reliable than your wife's forefinger.

One ounce of salt to the pound of butter is our rule, but always try to salt to please your customers.

It is much better to wash the milk out of the butter while in the churn than to work it out on the worker.

It is impossible for you to be too clean, either at the barn or dairy.

Keep your milk out of the kitchen; it absorbs all the bad odors and your customers will complain of the flavor.

Set aside your old dash churn, and buy a barrel, swing or box churn.

Churn your cream when slightly acid, and do not put it off to suit your convenience. Here is where you lose money.

Churning temperature, 62 degrees in summer; 64 degrees in winter. If you feed much cotton seed in winter you can get 68 or 70 degrees and it will do no harm. The lower the better.

You cannot make a first-class article of butter by feeding cotton seed alone. They spoil the flavor.

Cotton seed meal, or well steamed cotton seeds, fed in limited quantities in connection with other feed, will do no harm.

The farmers of Alabama can have a succession of green crops almost from one end of the year to the other. Add to this, cotton seed meal, raw cotton seed, and hulls, with good ensilage, they can make butter very cheap.

Raw cotton seed is like the sweet potato, it can be served in many ways. Place a high value on it and learn to feed it the right way, but never to excess.

When the patent butter maker comes around, do not let his persuasive tongue induce you to buy a county right to manufacture his butter. He is a fraud; let him alone.

Milk your cows ten months in the year.

Rich food will decrease the quantity of milk, but will increase the amount of butter.

The dairy business is a renovator, a restorer of worn out hands, and an educator of those who engage in it.

THE THEORY OF CATTLE FEEDING

The chapters on fertilisers have shown in detail the theory of fertilising, or the feeding of lands. The chapter on cattle feeding has confined itself mostly to the practical facts, without elaborating the theory. A brief consideration of the theoretical aspects of the question is here submitted.

There is a considerable similarity between feeding lands and feeding cattle. In both cases, the purposes to be accomplished (by the land or the cattle), must determine the amount and character of the feeding. Certain proportions of the fertilising chemicals are best suited for certain crops, and certain proportions of feeding chemicals are best suited for fattening stock; other proportions for milk production, and still others for work animals.

The recognised elements in feeding stuffs are principally (1) protein, (2)

carbohydrates, (3) fat. Other elements are water and ash.

Protein contains about 16 per cent. nitrogen, and the nitrogen is the important part from the standpoint of cost. This substance is consumed in the production of blood, muscle, milk, wool, hair, etc.

Carbohydrates and fat are fuels, which are consumed by the animal mechanism, primarily to produce warmth and power, and incidentally to store up surplus fat. The term "carbohydrates," as here used, includes the two items discussed in some works as "nitrogen—free extract," and "crude fibre." Both of these consist of carbon and hydrogen, and hence, for purposes of discussion as feed constituents, they are properly classed as carbohydrates.

The small amount of ash required in a feed is present in small quantities in all feeding stuffs. It is also supplied in salt. Its use in the animal economy is mostly for the building of bone.

Different feeding stuffs contain these three different essentials in varying amounts, and in varying degrees of availability or digestibility.

In tabulating the proportions of ingredients, only the digestible portion is considered. But in practice it is necessary always to have sufficient bulk, or in other words, the nutritive elements must be sufficiently dilute. For some reason, the process of assimilation goes on better when the animal's stomach is sufficiently distended. On this account, most tables contain an item "dry matter," which, in common with other items, is an indication of the bulkiness of the feed.

While carbohydrates and fat perform practically the same function as a feed, yet their relative value for this purpose is not the same: and in considering the two together under the same head, it is necessary to make an allowance to bring them to the same unit. It has been found by experiment that the value of fat is about 2¼ times the value of carbohydrates. Hence, in the tables the actual percentage of fat has been multiplied by 2¼ and added to the carbohydrates. The ratio between this combination and the protein is known as the "nutritive ratio."

The following table gives the average percentage composition, and the nutritive ratio, and relative feed value of some of the most common feeding stuffs:

TABLE XIX.

SHOWING COMPOSITION OF SOME COMMON FEEDING STUFFS.

FEED.	Relative Feed Value Per Ton.	Per Cent. Dry Matter.	Per Cent. Digestible. Protein.	Per Cent. Digestible. Carbohydrate and Equiv. Fat	Nutritive Ratio. 1 to
Cotton Seed Meal	$24.16	92	37	44	1.2
Linseed Meal	21.88	90	29	45	1.6
Cow Peas	21.20	86	19	54	2.8
Alfalfa Hay	15.24	92	10	43	4.3
Oats	17.72	89	9	58	5.9
Clover Hay	12.84	85	6	39	6.5
Corn	22.72	89	8	72	9.0
Timothy Hay	14.12	87	3	47	15.7
Corn Stover	10.16	60	2	34	17.0
Cotton Seed Hulls	9.96	90	½	35	70.0

This table is not to be taken as absolutely correct for any particular locality. It is compiled from a large number of sources, and represents a fair average of the well authenticated reports made by the several State experiment stations.

The column headed "relative feed value per ton," has been computed from average values determined at different times by the Connecticut station, and is 1.60 cents per pound for protein, and 1.40 cents per pound for carbohydrates. This valuation must be taken only as an approximation, and only as of relative importance. The stations all differ on this point.

The feeding stuffs have been arranged in the table with reference to the "nutritive ratio." Cotton seed meal is seen to possess the lowest or "narrowest" ratio, while cotton seed hulls possess the "widest" ratio. This means that cotton seed meal contains more and hulls less protein in proportion to other ingredients than anything else in the table. Hence in mixing a proper ration, the two extremes form a logical combination.

The Germans have made great study of the science of feeding, and they have developed what is called "feeding standards." By this is meant the proper nutritive ratios to feed to various animals to produce certain results. It is sometimes tabulated in a way to show the number of pounds of each nutritive ingredient that should be supplied for each 1,000 pounds of live weight.

The following table gives an idea of feeding standards considered about right for various purposes:

TABLE XX.

SHOWING FEEDING STANDARDS FOR CERTAIN PURPOSES.

ANIMAL.	Digestible Nutrients: Pounds per Day, per 1,000 lbs. live weight		Nutritive Ratio.
	Protein.	Carbohydrate and Equiv. Fat.	1 to
Growing Cattle—2 to 6 months old	3.2	16.0	5.0
" " 6 to 12 months old	2.8	15.0	5.4
Fattening Steers	2.5	16.3	6.5
Milk Cow.	2.5	14.3	5.7

The use of this table, together with Table XIX., may be illustrated by calculating a ration for a fattening steer weighing 1,000 pounds. Table XX. requires 2.5 pounds protein. Table XIX. shows cotton seed meal contains 37 per cent protein, hence there will be required (2.5 divided by .37) 6.8 pounds of meal. The table calls for 16.3 pounds of carbohydrates. The meal contains (6.8 multiplied by .44) 3. pounds, hence 13.3 pounds may be supplied by hulls (13.3 divided by .35) 38 pounds and a good ration would be say 7 pounds meal and 38 pounds hulls. On this ration, the steer ought to gain about 3 pounds weight per day.

It will be seen from the table that a milk cow requires very nearly the same ration as the fattening steer. With this feed she ought to give about 22 pounds of milk per day.

But the disposition of the fertilizing values that are in the feeds are different in the two cases. In the case of the fattening steer, very little of the nitrogen (in the protein fed) is retained. About 95 per cent. of it is voided, (22 in the solid and 73 in the liquid excrement). There is no nitrogen or protein in the composition of fat meat. On the other hand, the cow uses about 25 per cent. of the actual digestible protein that is fed. Milk is rich in protein. Protein contains all the nitrogen in the feed, and hence the manure from fattening steers is more valuable than from milk cows.

GENERAL NOTES ON CATTLE AND FEEDING.

LENGTH OF FATTENING PERIOD.

The Kansas experiment station found that in fattening steers on grain, the cost per pound for fattening increased after two months.

Actual practice in feeding cotton seed meal and hulls, throughout the South shows that it is not generally profitable to feed steers for fattening longer than three months.

AGE OF STEERS FOR FATTENING.

All stations agree that the younger the steer, the more rapid the increase of weight, and the less cost per pound for fattening.

AMOUNT OF FEED PER 100 POUNDS GAIN IN WEIGHT.

The average amount of a balanced ration required under normal conditions to produce a gain of 100 pounds in live weight, during the fattening period is about 1,500 pounds.

CHANGE OF DIET.

Milk cows relish changes of diet, and they prosper on it, when not too radical. But steers while being fattened will be content with the same diet throughout the period. Any radical change is sure to be detrimental. The Ohio station experimented on changing steers from pasturage to stall feeding, and vice versa. The change always reduced the rate of per diem increase.

PROPORTION OF HULLS AND MEAL.

The Texas station claims that the proportion of hulls and meal for fattening steers should be adjusted on the basis of the costs of these feeds, and that the cost of the hulls in a ration should be the same as the cost of the meal. For example, if meal is $20 per ton and hulls $4 per ton, then the economical ration should be in the proportion of twenty pounds of hulls to four pounds of meal, or five to one.

These methods of determining the ration seem arbitrary and artificial, and should not be too implicitly followed.

Experience shows that the best results come from beginning with a wide nutritive ratio, say one pound of meal to six or seven pounds of hulls, and gradually narrowing this ratio towards the end of the feeding period to four pounds of hulls to one pound of meal.

FEEDING UNDER SHELTER OR IN OPEN YARDS.

The Kansas station made a number of experiments to determine the difference between feeding cattle confined under shelter and feeding them when given liberty in the yard.

Their results were somewhat negative, for they could determine no difference in rate of gain under the two conditions; but they discovered that the cattle which were allowed liberty would consume about 12 per cent. more feed than those in the stalls.

These results should not be accepted as conclusive under all conditions. It depends upon the character of the animals themselves, and upon the character of the ground on which they are allowed to run. If the animals are wild and unruly, and are allowed perfect liberty of action, there will be much fighting and consequent damage and loss of flesh. If the ground is soft and not properly drained, the animals will bog up and lose considerable flesh, on account of the extra exertion in running over such ground. Unruly animals should always be confined in stalls. Tamer animals might be allowed some liberty, but should always be provided with shelter which they can reach when they desire.

There are some successful feeders in the Southeastern States, who make an open pen on a dry hillside, and in this pen have a large, cheap barn, entirely open at the bottom, so that the cattle may come and go to the feed troughs which are in this building. The upper story of the building is used for the storage of feed.

In any and all cases, more care should be given to the saving of the manures. The open yard should be kept continually strewn with cut straw, dry leaves or any other absorptive vegetable matter. This will absorb the urine and will be trampled down, and will help conserve all the fertilizing elements. The money and care expended on operating this kind of a fertilizer factory will bring better returns than any other department of farm industry.

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